ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLVI. No. 10. NEW YORK, SATURDAY, MARCH 11, 1905. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . LUCIEN W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single Copies, each 10
Copies supplied for only one year back, each 25

CONTENTS.

EDITORIAL:
Electricity in Agriculture . . . 397
Electrical Methods in Optical Pyrometry . . . 398
Will the Automobile Displace the Tramway? . . . 399
Telephone Engineering—XIV, by J. C. Kelsey . . . 400
An Electric Drive for Hydroextractors . . . 402
American Electrochemical Society . . . 402
An Important Italian Hydroelectric Installation, by Enrico Bignami . . . 403
New York Motor Boat and Sportsmen's Show . . . 405
The Proposed Central Power Station at Washington, D. C . . . 406
Fuel Economy in Steam Power Plants—III, by William H. Booth and John B. C. Kershaw . . . 410
Electric Plant in Formosa . . . 412
Transfusion (Electrical), by James J. Edmondson, M. D . . . 413
Electrical Notes from Europe . . . 414
The Ionic Theory of the Arc and Spark, by Professor Henry Crew . . . 416
Wireless Telegraphy in the Home . . . 421
Electricity in Agriculture, by C. L. Durand . . . 422
First Annual Convention of the Bell Telephone Company Managers . . . 423
The New Cunard Liner Caronia . . . 423
Important Marconi Invention . . . 423
Meeting of Electrical Contractors and Electrical Supply Dealers . . . 423
Strike on the Interborough Rapid Transit Company's System in New York City . . . 423
BOOK REVIEWS . . . 424
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 426
Electrical Patents . . . 428
INDUSTRIAL SECTION:
The Largest Electric Motor Ever Built . . . 429
A New Cook Protector . . . 429
Improved Angle Wall Sockets . . . 430
The "Firefly" . . . 430
Novelties for Fixture Work . . . 431
"Hiko" Electrical Specialties . . . 431
Small Motors Wanted . . . 431
New Form of Arc Lamp . . . 432
A New Cable Clamp . . . 432
Enclosed Automatic Engine . . . 433
Open Air Telephones, by George A. Long . . . 434
Reynolds-Corliss Engines . . . 434
CURRENT ELECTRICAL NEWS . . . 435

ELECTRICITY IN AGRICULTURE.

The introduction of electrical power for farmwork, whether it be for use in the field or in the barn, is taking place but slowly. They seem to be getting ahead in this direction rather more rapidly in Europe than we are in this country, but even abroad the electric motor is being applied but slowly, and only under most advantageous conditions. It is easy to show that the electric motor is an economical source of power for a large farm. In certain communities where the individual farms may be small, but where a certain amount of cooperation is possible, the electric motor has its advantages. This latter condition exists in southeastern France, where there are many waterfalls, but where the neighboring towns or factories do not give a full load on the station. In this section they have found it to pay to encourage the use of electricity for farmwork. The advantages of lighting farm buildings are, of course, of considerable importance, because of the inflammable nature of the contents. Where one motor may be kept fairly busy on several farms, the load which the station can obtain is such that it will make rates low enough to attract the farmers' custom.

The work which is now being done on farms in France and Germany includes practically everything except haulage. There are several systems in use for plowing, and the machinery in the dairies and the barns, whether the latter be for thrashing grain or other purposes, is, in a number of cases, now driven by electric motors. The reports from these plants seem to indicate that the system is working profitably.

In this country there are, it is true, some few instances where the farm machinery is driven by electric motors. Such applications are on large farms. On some of them an isolated plant has been constructed, which lights all the buildings on the farm, and supplies power for operating the motors. Of course, such a system would not be economical for every farm. It is probable that it would pay only on large farms. But there would seem to be a good many localities where wind power might be used to advantage. The variable character of the supply would not be particularly objectionable, as there is no need to follow a fixed routine in doing farmwork. During stormy weather, when work outside can not be carried on, there is generally sufficient wind to supply power for doing indoor work, and when a windmill is installed for doing this work the addition of a storage battery makes a satisfactory lighting system possible.

Given a windmill located at the barn, there may seem to be no necessity for adding a dynamo, but with a simple wind drive all the work must be done at one point. Adding an electric system enables work to be done at any part of the farm, and the additional advantage of lighting by the best system known.

Where conditions do not justify the investment required for a power plant on the farm, whether it be operated by steam, gasoline or wind, there still may be a good field for the electric motor which derives its supply from a neighboring power plant. The load in general would be a desirable one for the station; hence low rates for power could be made. It is probable that where a motor is installed, lights would also be put in the house and farm buildings. Even should the work of any particular farm be too light to justify the purchase of a motor, the supply company or others might build up a very profitable business by renting out semi-portable motors. These could be carried from point to point, as the traction engine is used to-day.

We have not yet reached a stage in our automobile development where the farm horse can be replaced, and as long as a horse is necessary on a farm, the stand may be taken that there is no need for any other power; but there are few farms which keep all their horses busy all the time, and the work which must be done by the horses could be done by a smaller number if another source of power were available for occasional work. It is a field which is at least worthy of investigation by the manager of the light and power plant situated in a small country town.

ELECTRICAL METHODS IN OPTICAL PYROMETRY.

Two purely electrical methods of temperature measurement were discussed recently, and some of the advantages and disadvantages pointed out. Stress was laid upon the comparatively small cost of such instruments, since this makes it practicable for every laboratory to be equipped with a satisfactory instrument. There are, however, instances when neither of these instruments can be applied. These occur when it is impracticable to introduce the electrical pyrometer into the place where the measurement is to be made. The inability to do this may be due either to the temperature existing at that point, or to the mechanical difficulty of inserting the pyrometer. Some other method of temperature measurement then becomes necessary.

This need is being met by optical methods of temperature measurement. The instruments which have been devised make use of several phenomena, which have been the subject of an important study by Messrs. C. W. Waidner and G. K. Burgess, of the National Bureau of Standards, Washington, D. C. Some of them are purely optical, depending merely upon the measurement of luminous radiation. The term "optical pyrometry," however, is very properly made to include measurement of temperatures at which there is little or no visible radiation. In a certain class of instruments, while the measurement depends upon the luminous radiation, the adjustment is secured through electrical means. In still another class of pyrometers the determination depends upon a purely electrical effect.

To make use of a measurement of radiant energy, such as light or heat, for determining temperature, some relation must be established between the amount of radiation of a body and its temperature. There are several laws for this, all of them deduced by empirical methods. They hold with more or less accuracy throughout certain ranges of temperature, and researches indicate that they are applicable to temperatures above those measurable by other methods. There are certain limitations to these laws which have a significant bearing on their application to temperature measurements. The radiation from a hot body depends not only on its temperature, but upon special properties of that body which are not well understood. Thus, two bodies may be maintained at the same temperature, and yet the radiation of one will differ from that from the other. The temperature determinations depending upon a simple measurement of radiation will give exact results as long as the temperature of one material is considered, but will not give concordant results when applied to another material. The recognition of this fact has led to the definition of "black body," this being one which radiates all the energy which it receives, but which does not reflect nor transmit any. It may, however, be possible, in the laboratory at least, to place a body under such conditions that it will behave as a black body; but, unfortunately, this condition can not always be attained in practice. If it could be, optical methods of measuring temperature would be simple and exceedingly accurate.

As is well known, determinations of luminous radiation which depend upon the eye are subject to serious errors, but, fortunately, the laws connecting luminous radiation and temperature are such that this method of determining temperature permits of great accuracy. The luminous radiation of a body increases many times faster than its temperature, so that, other sources of error being eliminated, an approximate measurement by optical means would give a far more accurate temperature determination. It is this law which has been taken advantage of in industrial applications for temperature determinations. The expert in charge, after long training, acquires considerable skill, and estimates temperatures by means of the brightness and color of the material with which he is working. Much dependence has been placed upon this method, for want of a better one, but obviously it is entirely unsuitable for scientific work, and there is too great a chance of error even for industrial purposes. The need of more exact methods of conducting industrial operations is now well recognized. This relation between temperature and luminous radiation which has made it possible for the eye to estimate approximately the condition of a material affords an opportunity for a simple and accurate method of temperature measurement. Comparing the luminous radiation from a body whose temperature is desired with that of another body which has previously been calibrated enables the temperature of the former to be determined with considerable accuracy, but it must not be forgotten that the temperature of the two bodies may not be the same, since the character of the radiation of the two will probably be somewhat different. This fault would be serious for scientific work if the relation between temperature and radiation of the body to be investigated could not be determined. For industrial application this difficulty is not serious, since then the necessity is not to determine the absolute temperature, but to be able to reproduce a certain temperature.

In all pyrometers whose readings depend upon luminous measurements, a standard of comparison is employed, and by varying the radiation from this or the body being investigated, a comparison is made and the temperature deduced from this. The variation may be made by reducing the amount of light radiated from suitably adjusted screens, and there are a number of ways of accomplishing this. Although the variation may not be accomplished by electrical means, it has been found that an incandescent lamp offers the most satisfactory standard, simply because it is easier to reproduce a given condition in an incandescent lamp than in other luminous bodies. The variations may, however, be brought about by varying the current through the filament of the incandescent lamp. This is a pretty method, and has an advantage in that the color of the light changes with a change in temperature, following more or less the color changes of the hot body being examined, and making, in general, a more exact adjustment possible. The comparison may be made directly between the filament and the hot body, or between two screens, each illuminated from one source. The former method is possibly the simpler of the two. It has been applied in two ways: by means of a telescope an image of the hot body under investigation is brought into the plane of the filament of the incandescent lamp, or the telescope may be omitted and the fila-

ment viewed with the hot body as a background. The current in each case is adjusted until the whole or a definite portion of the incandescent filament can not be distinguished from the background. Both of these methods permit accurate work to be done, provided the necessary precautions are taken. It must be remembered that not only are the radiations from the different bodies at the same temperature different, but each of the incandescent lamps will have its own characteristic, so that each standard must be independently calibrated, and the lamp must be handled with care, so as not to upset its constants. These are the precautions which should be observed in the use of the incandescent lamp for photometric standards.

There is still another method of pyrometry, depending upon an electrical effect. In this a thermoelectric couple is used, and an image of the hot body focused upon it. In this, optical measurements are not made directly. The method is subject to the errors of thermoelectric pyrometry, but may have advantages in certain classes of work.

The art of pyrometry has advanced greatly within the last ten years. Electrical methods have played no small part in this, and even though they can not be used directly, they may be used with advantage with methods depending upon other effects. It is difficult to estimate the importance of this art, but it will doubtless make possible advances in many industrial applications which heretofore have been thought unattainable.

WILL THE AUTOMOBILE DISPLACE THE TRAMWAY?

From time to time, as the automobile has been improved, it has been suggested that probably the new vehicle would displace the tramway or the car running upon a special way. To uphold this view it has been stated that the automobile bus will not cost any more to operate, if, indeed, it would not be cheaper because of the saving of expenses of laying and maintaining a track. It is also thought that a vehicle which is not confined in its movements to a track could make better time, because it would be able to run around an obstacle, whether it be a slowly moving vehicle or another car of the same system which has met with an accident. Other supposed advantages are the elimination of tracks from the streets, and the ease with which a route may be changed and advantage taken of several parallel streets when traffic on one particular route becomes dense.

The question has been examined by Mr. Henry M. Sayers, who gives his conclusions in the *Electrician* (London), for February 17. Mr. Sayers concludes that the advantage rests with the tramway. It is true his consideration is limited only to London conditions, but he points out the limits of his deductions. He finds that, comparing two of the larger companies in London, one operating nearly 1,400 buses, and the other operating 520 tramway cars, while the former carried fifty per cent more passengers, in order to do this, over 100 per cent more miles were run. The operating cost per vehicle-mile was greater. Thus, he finds that the cost per bus-mile was about 15.7 cents, while the cost per car-mile was only 12.1 cents. The cost per passenger transported was still more in favor of the tramway company, for it costs the bus company 2.4 cents for every passenger carried, while it cost the tramway company only 1.25 cents. These are the costs of operating the vehicles only. When the cost of maintaining the track and the pavement is added to that of operating the tram-cars, the advantage still remains in favor of the tramway system. Allowing for this, it was found that the cost per vehicle-mile of tramway was 15.1 cents, while the cost per passenger was 1.56 cents. These are to be compared with those quoted above for the bus system, since the latter has no track to maintain.

As to the advantages of freer movement on the streets, it is held that these are offset by the greater speed at which it is permissible to operate the cars. It is a very different thing to control a rapidly moving vehicle which is limited to a certain narrow strip of the street, than to control a vehicle which may run anywhere. In other words, when the driver must guide his vehicle, as well as control its speed, he should not be allowed to attain a maximum speed as high as that of a tramway car. According to this, the bus would lose much, if not all, which it would gain by being able to dodge or pass around other vehicles. There is a good deal of logic in this argument, and no doubt the general public would take this position.

As against the objection to tracks on the street, it is pointed out that the tramway company pays for the privilege of placing them, either by a direct tax or by maintaining more or less of the pavement of the street. With the bus system there is no such return. Instead of maintaining a street in good condition, the buses assist in wearing.

It is held by some that the expense of operating a gasoline or steam bus can be made less than that of operating an electric tramway car. If this be the case—and Mr. Sayers does not admit it—he thinks that the proper thing to do would be to change over our electric systems, and use gasoline or steam-moved cars on the tracks. Thus, the saving in operating expense, due to the use of a track, would be added to by that brought about by the new motive power.

It is admitted that these conclusions are not generally applicable, for, with decreasing traffic, the point may be reached where the cost of maintaining the track and the pavement may be such a great proportion of the total cost of operation as to make the tramway the more expensive of the two systems. Where such conditions obtain, it would be proper to adopt the automobile bus, provided the prospect of increased traffic is not sufficient to warrant a greater expense for the tramway system. The proper place for the automobile omnibus is along routes where they may serve as feeders to existing railway systems. In this field there will still be a considerable choice of system, for it may be found that the so-called trackless trolley system would be better than a pure automobile system, particularly when it is expected to convert the system to a tramway later on. A combination of an electric automobile and a trackless trolley system has some advantages for rural districts, as the vehicle would not be entirely dependent on the overhead system, and would be able to pass over routes where overhead conductors were not provided. It could charge its batteries while running under the trolley, and use this charge in passing from one route to another. The batteries for this service need not be very heavy, and the bus could cover a large area where even a trackless trolley system would not seem warranted.

TELEPHONE ENGINEERING—XIV.

BY J. C. KELSEY.

TELEPHONE SYSTEMS WITH SLIGHTLY CHANGING LINE CONDITIONS.

The first three systems discussed, Bell, Kellogg and Stromberg-Carlson, belong to the cut-off relay class, in which the line conditions go through a complete cycle of change. When the subscriber removes the receiver the line becomes charged. When the operator inserts plug to answer, the line discharges and an instant later the complete insertion of the plug charges the line again. This change in line conditions manifests itself in a severe receiver click, followed by a much milder click. The severe click comes from the opening of the line, and the rapid rate of change in the magnetization of the induction coil. The milder click is caused by the comparatively slow growth of the current in the line upon the introduction of the plug, by reason of the impedance of the induction coil.

The Sterling and the Western Electric Company No. 8 systems belong to the permanently bridged and balanced relay class, in which the entrance or withdrawal of the plug causes no change in the condition of the line. As a result, the subscriber is not aware of any receiver clicks coming from the operator's actions.

There is another class of systems, rather a combination of the above classes, in which the line signaling apparatus is permanently placed in the circuit, and the entrance of the plug increases the amount of current in the line circuit for talking purposes. We have found that it is the opening of the line that gives the severe receiver click, while the reintroduction of battery on the line gives but a mild click, which is governed by the time-constant of the induction coil.

Such a system has been designed by Mr. H. P. Clausen, of the American Electric Company. For ingenuity and daring this system deserves the highest place. The systems so far discussed have either cut the line lamp out of circuit entirely or have paralleled the line lamp by the cord lamp, but Mr. Clausen simply parallels the line relay by the cord relay, causing it to become inoperative. For efficiency and good operation, hundreds of systems and thousands of subscribers bear daily witness to its excellence.

Fig. 23 reveals this system, which is ostensibly a three-strand system, yet having many characteristics of the two-strand. For instance, one side of the talking circuit serves as a test terminal. This means that the busy testing devices are of a two-strand nature and great precautions have to be taken to prevent the plug tip touched to the test terminal from lowering the potential of the line, and giving the talking subscribers a disagreeable series of clicks. A use of a talking strand for lighting the cord lamps reveals a two-strand characteristic.

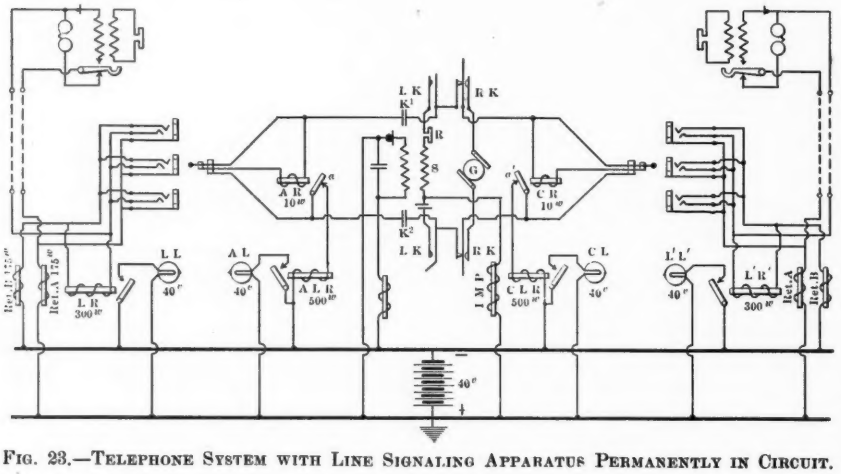


FIG. 23.—TELEPHONE SYSTEM WITH LINE SIGNALING APPARATUS PERMANENTLY IN CIRCUIT.

Removing the receiver from the hook causes current to flow from the negative terminal of a forty-volt battery, through retardation "Ret B," through the 300-ohm line relay LR, through the instrument, thence back over the line to the test terminals, thence to positive battery through retardation "Ret A." Relay LR becomes energized, attracts its armature, causes line lamp LL to light; also a pilot relay, not shown in sketch, to become energized and light a pilot lamp, also not shown.

The operator plugs in and lamp LL and the pilot lamp are extinguished, because the ten-ohm cord relay AR has been placed in parallel with 300-watt relay LR and has weakened it to such an extent that it releases its armature contacts.

Lamp AL, the answering supervisory signal, is also extinguished, as the receiver being off the hook causes AR to become energized and attracts its armature. This breaks the contact *a*, which breaks the circuit of the answering lamp relay ALR which opens circuit of AL.

The operator throws key LK, ascertains number desired, and makes a test in the usual manner. The sleeve of the jack or test terminal is normally at positive or ground potential. Likewise, the tip of the plug is at same potential. Therefore, the touching of the tip to the test terminal causes no test current to flow and the operator plugs into the jack and rings the subscriber with RK.

Had the line been busy a negative potential would have existed on the test terminals and testing currents would have flowed from the busy sleeve to the plug tip, thence through the operator's receiver R through the induction coil secondary S, thence through IMP the safeguarding test impedance, measuring several thousand ohms, to ground. Each time the operator touched the terminal she would receive a resulting click, definite and reliable.

The act of plugging in lights the calling lamp CL, as battery has a path through the relay CLR, through contact *a'* of CR, through sleeves of plug and jack, thence to ground through the retardation "Ret A."

When the subscriber answers the relay CR is energized, prevents L'R' from operation, opens contact *a'* and deenergizes relay CLR, thereby opening circuit of CL.

When the parties hang up receivers the lamps AL and CL light and operator pulls down the connection.

The retardation coils A and B individualize the circuit, prevent cross-talk, cut down extraneous noises and regulate the flow of direct current. The relay in the cord circuit has high impedance, but of itself is not enough to prevent cross-talk nor to reduce extraneous noises. Subjected to considerable static strain this system is comparatively quiet, although not exactly balanced.

Another system of this class, shown in Fig. 24, reputed as belonging to the North Electric Company, reveals a well-balanced system with a natural busy test and using three strands.

Permanently bridged across the line circuit is a tandem relay with 300-ohm windings and connected to a twenty-four-volt battery. When the subscriber removes his receiver the relay is energized

and contact *a* is closed. This causes line lamp LL to light, the circuit being contact *a* of LR and contact *b* of relay COR.

When the subscriber removes receiver the line is charged with twenty-four volts flowing through 600 ohms and the natural line resistance. When the operator inserts the plug to answer, the line conditions are changed because the cord relay AR with its 115-ohm tandem windings parallels the 300-ohm windings of LR and the resistance of the circuit is lowered 435 ohms, which allows a corresponding increase in the line current. As the induction coil impedes the rise of the current, the subscriber only hears a mild click.

The insertion of the plug operates relay COR and opens circuit of LL at *b*. Supervisory lamp would also be darkened, as relay AR is energized and opens the lamp circuit at point *c*. To prevent the sleeve circuit from being opened at back contact *c* and thereby releasing relay COR the inner contact *d* puts 300 ohms in series with COR and thus holds the relay at all times. In parallel with lamp AL are two resistances in series, one 200 ohms and the other 300 ohms. They will not dim the lamp in any way and serve to prevent the releasement of COR. As the relay AR attracts its armature there is an instant of time when the cutoff relay circuit is open. As COR is a low-resistance relay, it will quickly demagnetize, but all the time the circuit may be open between the contacts *c* and *d* the circuit is still closed through COR and the 500 ohms. This will temporarily hold COR, or preferably delay its releasement until contact *d* is closed.

The operator answers with LK and tests for desired number. Both plug and jack sleeves are normally at positive or ground potential and no testing current flows. If the desired line is busy a negative potential exists which will cause current to flow from the busy sleeve to the tip of the testing plug CP, thence to ground through the upper winding of relay CR. Energy is therefore stored in the core of the relay CR. When the tip is removed the energy in the core dissipates and the rapid change in the magnetization of CR develops a pressure which forces a current through the bridged operator's receiver. The waiting subscriber also hears the test made as the condensers K^1 and K^2 make a path through the instrument.

Inserting the plug in desired jack lights CL in series with C′O′R′ and opens contact *b′* so that line lamp L′L′ will not light when party answers. When the party answers, relay CR is energized and LR as well. Contact *c′* is broken, CL is extinguished, contact *d′* made, which puts 300 ohms in series with COR and makes sure the energization of COR.

When the subscribers hang up receivers, AL and CL light up.

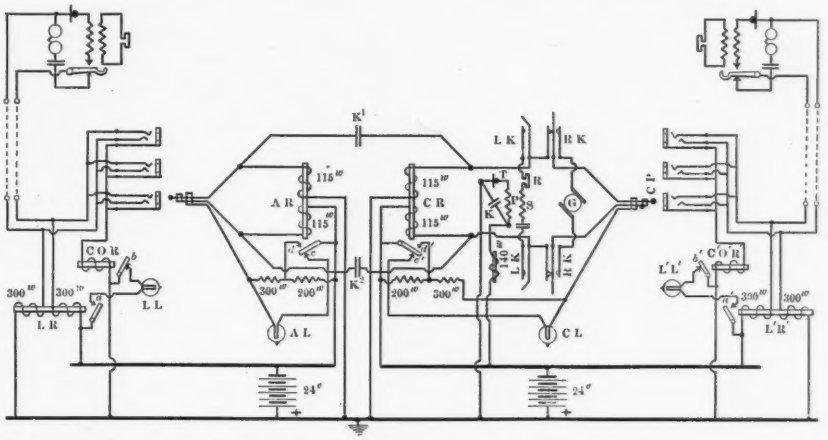


Fig. 24.—Telephone System with Line Signaling Apparatus Permanently in Circuit.

This system makes use of line and cord pilot signals, single-voltage lamps and has the only natural busy test in the independent list. The use of two batteries reminds one of the Kellogg system. Experience with thousands of subscribers bears out what inspection plainly shows, that this system is one of the successful commercial systems.

Another system of the same class is shown in Fig. 25, reputed to be used by the International people. Unlike the American and North, it is a two-strand system, and necessarily has to make use of rather bold expedients. It will be noticed that the line circuit consists of two relays in series with a twenty-four-volt battery. It looks reasonable that when the receiver is removed from the hook that both relays LR and COR would become actuated. But the relay COR is adjusted, so that when placed in circuit with LR, the line and instrument, it will not become actuated.

LR will become energized, light lamp LL through contacts *a* and *b*. The operator inserts the plug and line lamp LL is extinguished as COR is actuated by being placed in series with ALR, a relay of 450 ohms resistance. COR opens contact *b*, relay ALR closes contact *c* and causes both lamps AL and CL to become lighted. But since the subscriber is waiting the relay AR in parallel with LR will be energized and opens circuit of lamp AL at *d*.

The operator, throwing LK, communicates with subscriber through condenser K on tip side and sleeve side of the circuit. If the desired line is not busy, she plugs and rings with RK. Inserting the plug makes no change in the lamp already lighted but relay C′O′R′ is actuated, being in series with ALR of 450 ohms. The adjustment is necessarily close, somewhere between 450 ohms and 600 ohms

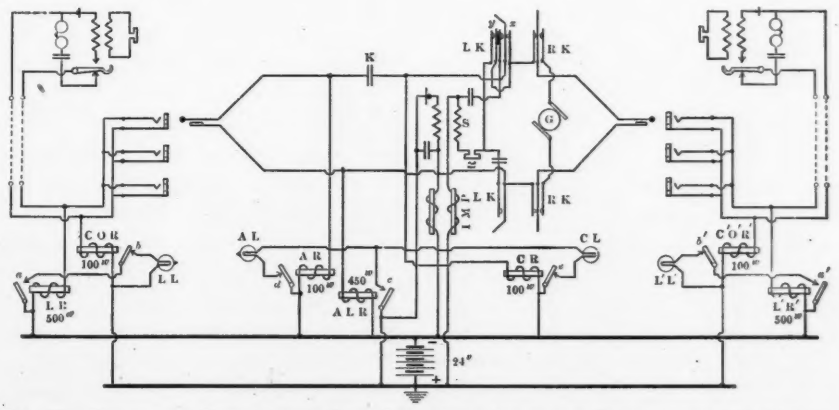


Fig. 25.—Telephone System with Line Signaling Apparatus Permanently in Circuit.

for the shortest lines. Each line would have a particular adjustment and this can be called a weak point, for a relay has to be most carefully adjusted to discriminate between 450 and 600 ohms.

When the party answers, relay CR is actuated and opens contact *e* which extinguishes lamp CL. Battery is furnished for conversation through the COR relays in the line circuit and relays AR and CR in the cord circuit. These relays balance the circuit, individualize it and free it from cross-talk. However, LR and COR furnish enough energy for talking because the use of key LK cuts off CR from the called party when the operator breaks in on the conversation.

Had the line been busy the test terminal would have been at negative potential instead of positive and the clicks would have resulted. But the tips of this system are normally negative while the test terminal is normally positive. A false test would result. To get around this the negative potential of the tip is removed while the test is being made and the tip of the plug connected to ground or positive through the receiver and a suitably high impedance to prevent the sudden lowering of the potential of the talking circuit. This is done by LK, in which contact *x* is broken and contact *y* closed. Then the testing current flows from the negative test terminal through plug tip, contact *y*, receiver R, secondary winding S, through impedance IMP and to ground. The receiver notes the click and owing to the high inductance of IMP the talking subscribers are but faintly aware of a test being made on the lines.

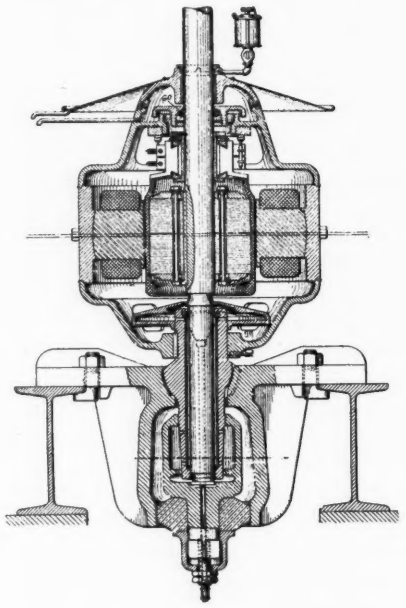
If the operator listens on a conversation, the receiver and secondary and two condensers are thrown in series on one side of the line, and the electrical condition of the line is changed as CR is removed from the circuit. But this case is rare in a common battery system. There is no necessity for listening.

When the subscribers hang up, relays AR and CR release armatures, lighting up AL and CL; withdrawing plugs deenergizes ALR and lamps go out.

The underground railway system of London is operated only in part by electricity, steam locomotives still being employed on a number of the lines. When the electrification of all the subways is completed, as planned, one will be able to travel sixty miles underground without running twice over the same piece of track.

An Electric Drive for Hydroextractors.

An electrical drive for hydroextractors has been recently patented by William L. D'Olier, of Philadelphia, Pa. The invention relates to apparatus, such as is employed in laundries, dyeing establishments, and the like, or in any relation where it is desirable to separate liquids from solids, liquids from liquids, or solids from solids by means of centrifugal action. The invention comprises a centrifugal machine of any well-known type driven by an electric motor, the whole being so disposed that the motor and centrifugal may deflect from a given normal position under the influence of dissymmetry of the parts themselves or on account of the unsymmetrical loading of the centrifugal machine. An electric motor is also employed which is directly connected to a centrifugal machine, the centrifugal machine being mounted above the electric motor, the rotating elements of the motor and the machine being both secured to a rotatable vertical shaft, which shaft bears at its lower portion. The fixed and rotatable elements of the electric motor are so arranged that, when the motor is loaded, there is a tendency to float the rotatable elements of the motor, the shaft and the centrifugal machine, so that the centrifugal machine is, in fact, magnetically floated, whereby the friction effects are greatly reduced. The centrifugal machine is arranged above a floor or platform, the motor driving the same by direct connection and located below such floor or platform.



ELECTRIC DRIVE FOR HYDROEXTRACTORS.

American Electrochemical Society.

The annual convention of the American Electrochemical Society will be held at Boston and Cambridge, Mass., April 25, 26 and 27. The headquarters will be at the Hotel Lenox, Boston.

The following papers have been promised:

A. Reuterdahl, "The Interdependence of Atomic Weights and Electrochemical Equivalents."

C. Hambuechen, "An Optical Method of Observing a Diffusion in an Electrolyte."

A. B. Albro, "The Microstructure of Silicon and Silicon Alloys."

Dr. L. Kahlenberg, "Paper on Osmosis."

Professor C. F. Burgess, technical paper.

Professor H. R. Carveth, "Electrolytic Precipitation of Chromium."

Doctor J. W. Richards, "Conduction in Electrolytes."

Professor J. C. Blake, "The Migration and Coagulation of Colloidal Suspensions."

C. G. Richardson, "Water Power of the Canadian 'Hinterland.'"

R. C. Snowdon, "Electrodeposition of Silver."

R. C. Snowdon, "Adherence of Nickel to Nickel."

Ernst Fahrig, "Treating Low Grade Ore and Tailings by Electrolysis."

Carl Hering, "Removing Solvents During Electrolysis."

A. Lodyguine, "Some Experiments with the Reduction of Titaniferous Ores into Steel and Titanate of Iron. Experiments with the Reduction of Different Oxides of Lead by Electric Current." "Some Results of Experiments with the Electrodisposition of Metals on Aluminum."

H. M. Goodwin, "On Billitzer's Method of Determining Absolute Potentials."

G. A. Hulett, "A Low-Voltage Standard Cell."

A writer in a current issue of a contemporary, states that the ordinary acid solutions should not be used as a flux in soldering electrical connections. The acid solutions will attack the insulation if they come in contact with it. A noncorrosive flux can be made by dissolving rosin in alcohol.

An Important Italian Hydroelectric Installation.

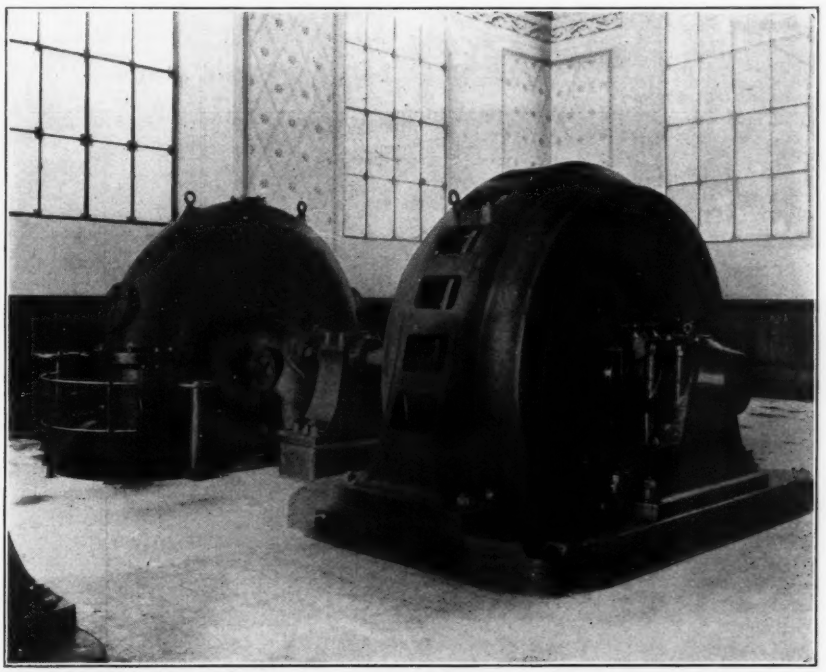
Description of a New Water-Power Station Planned by Italian Engineers and Equipped Entirely with Italian Machinery.

By Enrico Bignami.

IN RECENT years many electric installations have been made in Italy, particularly for developing water powers, and before long every small village will have, it is believed, its own. But those which have been made up to this time—at least the more important ones—have been carried out entirely or in part with material and machines furnished by foreign houses. Now, however, the rich and busy district of Royaume counts, among others, an important hydroelectric installation which was made recently, and entirely by Italian firms, nearly all of these being of Milan.

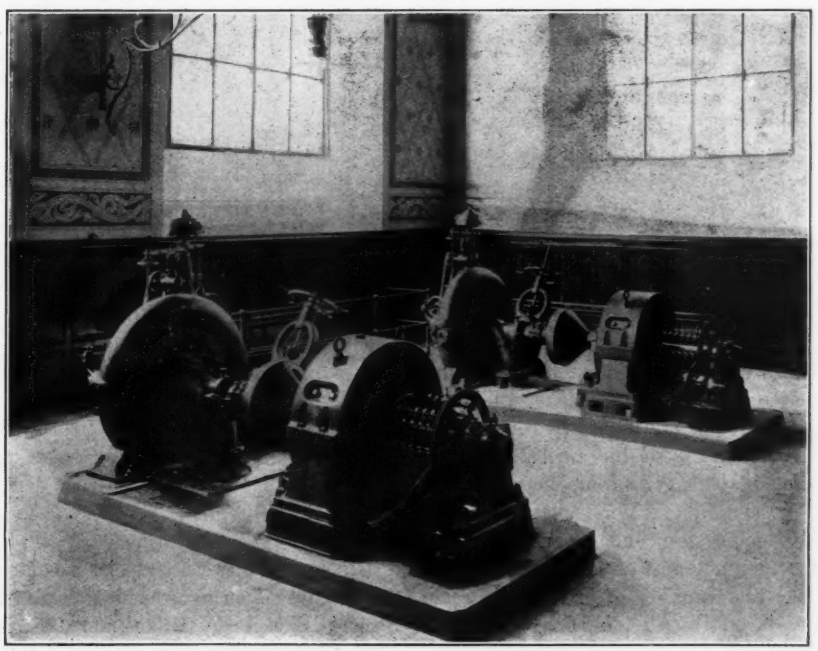
This installation is at Zogno, in the province of Bergamo. It makes use of a branch of the Brembo, the utilization of which was proposed in 1889 by an Italian engineer, Signor Guiseppe Villoresi. Following him, the Societá Anonyme pour Entreprises Électriques Conti, of Milan, acquired the rights, and, having overcome much local opposition, obtained a concession and constructed a plant, which was put into service a few months ago.

The quantity of water which the company may use is estimated at ten cubic metres per second with a fall of 57.6 metres. This gives a power at the shafts of the turbines of 6,000 horse-power. The head works are in the neighborhood of the village of San Pellegrino, which is celebrated for its mineral baths. They consist of a curved dam fifty-two metres long, with the lower part stationary, constructed of concrete, and the upper part adjustable, according to the Poiret system. There is an intake house furnished with three gates and a waste weir, etc. The dam is founded on rock, at a depth of eight metres below the bed of the river. These foundations were made during the winter, without it being necessary to adopt any special system of work. The flow of the river was deflected so as to leave first one half of the bed of the river dry, and then the other. The banks of the river were graded to correspond with the intake works, and covered with stone. The canal for conducting the water away from the dam is 7.5 kilometres long, and it winds, in part, along the side of mountains, and in part through tunnels, one of these being more than a kilometre in length. It passes through two inverted siphons. The discharge canal is 500 metres long. There are four pipe lines, each formed of a steel pipe 1.3 metres in diameter and 102 metres long. There is, in addition, a fifth pipe for driving the exciters.



TURBINE AND ALTERNATOR, HYDROELECTRIC STATION AT ZOGNO, ITALY.

The station is situated in the suburbs of Zogno. It is a large building and—sometimes rare for such installations—is very carefully designed with respect to its architecture. It contains four Francis double turbines, each rated at 2,000 horse-power when operating at 315 revolutions per minute. These are directly connected to three-phase alternators, without the use of elastic couplings. One of the alterna-



EXCITER UNIT, HYDROELECTRIC STATION AT ZOGNO, ITALY.

tors is held as a reserve. The voltage of the generators can be varied from 2,400 to 2,600. Two small Pelton wheels, rated at 150 horse-power each, and operating at 600 turns per minute, drive the exciters. To each alternator are connected three three-phase transformers, rated at 600 kilovolt-amperes each. These raise the tension to 24,000 volts.

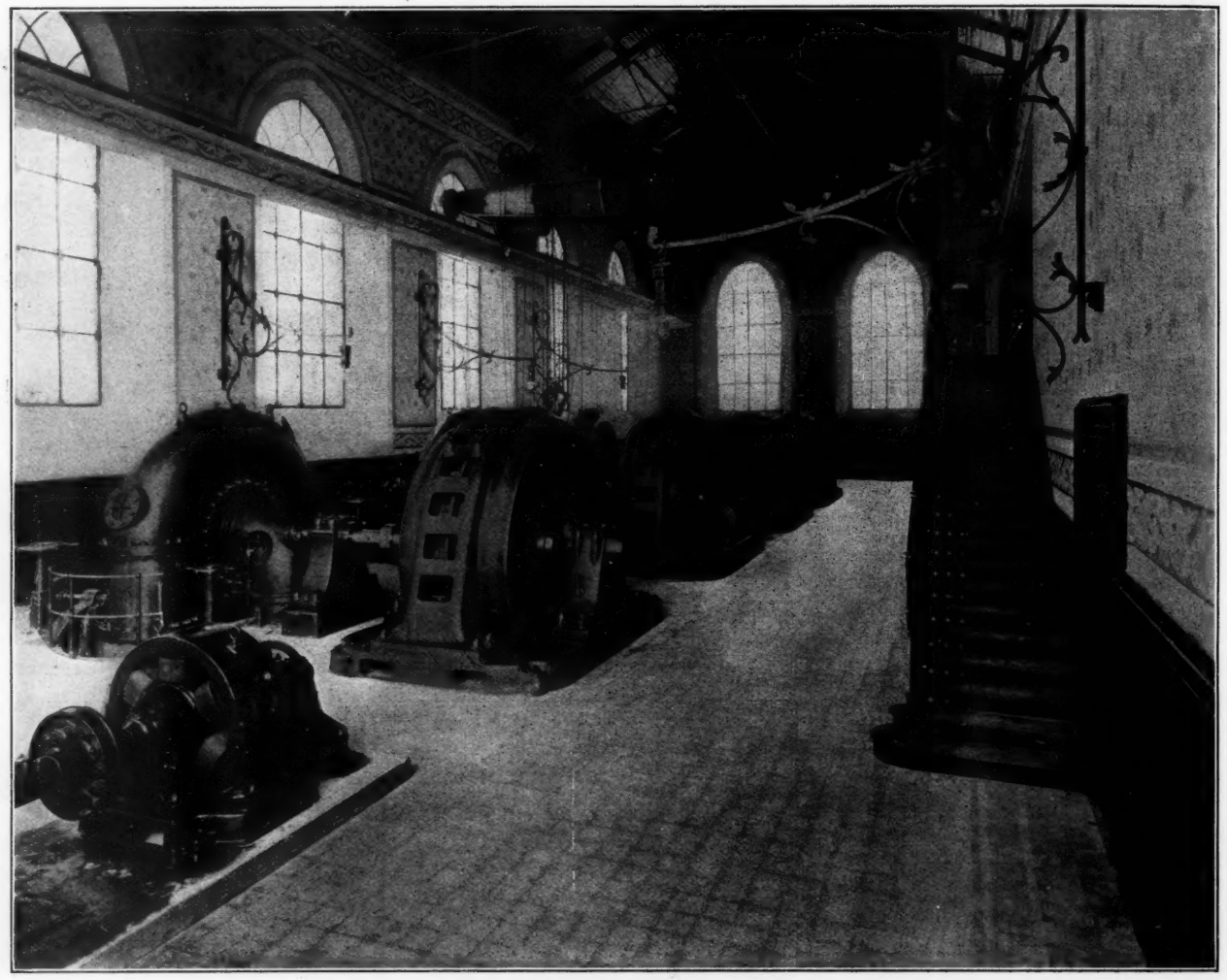
The distributing switchboards are rather remarkable technically, for no switches or marble is used in their construction, and the high-tension and low-tension circuits are separated completely. All the elements of the switchboard are separated. This gives complete reliability for the station operators, guarantees the plant against fire, and carries, in addition, other noteworthy advantages.

The line consists of five wires, each 8.5 millimetres in diameter. In the mountainous sections it is placed on poles a great distance apart. Along the plain the distance between the poles is sixty metres. These poles are of a new type, and are elastic in the direction of the line. This type of pole is due to an idea of Signor Ettore Conti, the engineer for whom the company is named. He had in mind not only elastic poles, but also believed that, should all the wires break simultaneously, the neighboring poles could be depended upon to take up the tension, which would decrease gradually as the strain was transmitted from pole to pole. On this hypothesis he has been able to diminish notably the weight of the poles, and, as a consequence, their cost.

The line runs from Zogno to Arcore, and has a length of 35.5 kilometres. From Arcore the energy is distributed to Monza, Carate, Desio, Seregno, Meda Mariano, Bovisio, Seveso, Mombello and all the districts lying between these large centres. On account of an agreement between the Société Edison de Milan and the Société Conti, the energy supplied by the Brembo plant takes the place of that formerly distributed from the Paderno installation, so far as its sale in the territory of Monza is concerned. It will be more profitable to the Société Edison to dispose of the energy transmitted from Paderno at Milan. The Société Conti has also taken the place of the Société Monzese.

The patriotic feeling of the Italians is flattered by this installation, which has been carried out—and profitably—entirely by home industries, which have thus shown again that they can compete successfully with foreigners. The electrical part was planned and carried out by Gadda, Brioschi & Company, of Milan. The screens, water gates and all mechanical accessories were furnished by Larini & Nathan, of Milan, and the turbines by Riva & Monneret, of Milan, also. The pipes were furnished by the Forli works, the iron poles by the Savigliano works, and the insulators by the Société Richard & Ginori, also of Milan.

The Société pour Entreprises Électriques Conti is indebted for its success to its management. The company also



Interior View of Power-House, Hydroelectric Station at Zogno, Italy.

owns an installation at Cerano-Trecate, and is planning to construct one at Buffalora on the Tessin, and a third at Vigevano, where 6,000 horse-power will be generated, which will be transmitted to Milan.

POWER-HOUSE, HYDROELECTRIC STATION AT ZOGNO, ITALY.

TRANSMISSION LINE FROM HYDROELECTRIC STATION AT ZOGNO, ITALY.

National Electric Light Association.

The National Electric Light Association announces that the Jury of Awards of the St. Louis Exposition has awarded it a gold medal for its publications and its work in advancement of the electric lighting industry.

The data asked for by the association, to be used for the annual revision of its "Municipal Lighting Statistics," are being returned this year with unusual promptness.

The first list of questions for the 1905 question box, edited by Mr. Homer E. Niesz, 139 Adams street, Chicago, Ill., has been sent out. The list contains 444 questions, covering twenty-six headings. This list has been sent out to all of the electric light companies in the United States and Canada, and to electrical manufacturers, engineers, dealers and technical colleges. Answers are desired from all who are competent to reply to any one or more of the questions. These replies should be received by March 24.

New York Motor Boat and Sportsmen's Show.

At the Motor Boat and Sportsmen's Show, held at Madison Square Garden, New York city, February 28 to March 9, there were a few exhibits of interest to electrical people.

The Edison Manufacturing Company, Orange, N. J., had an exhibit of primary batteries and spark coils. A number of the motor boats and gasoline engines in operation at the show used these batteries and spark coils.

The Marinette Gas Engine Company, Chicago Heights, Ill., had a gas engine on exhibition, which was direct-connected to a nine-kilowatt, 125-volt generator.

The Electric Launch Company, Bayonne, N. J., had a number of auto-boats on exhibition, and a thirty-foot electric launch in operation in the large pool in the centre of the building. Included in the Electric Launch Company's exhibit was a General Electric mercury vapor rectifier, used in charging the batteries of the electric launch.

William Roche, New York city, had an exhibition of spark coils and dry batteries.

C. F. Splitdorf, New York city, exhibited a number of spark coils, among them a new form of coil which has been brought out especially for marine work. These coils are all provided with a new form of vibrator which has lately been applied to the Splitdorf coil.

The Dayton Electrical Manufacturing Company, Dayton, Ohio, had an exhibition of Apple ignition dynamos.

The Metz & Weiss kerosene engine was represented by a number of engines in operation. One of these was direct-connected to a generator which supplied energy for operating the electric sign over the company's booth.

It is proposed to fit lightships Nos. 71 and 72 with apparatus for wireless telegraphy. These lightships are located on the Diamond Shoals on the coast of North Carolina.

The Proposed Central Power Station at Washington, D. C.

Mr. Bernard R. Green, superintendent of Library Building and grounds, Washington, D. C., has submitted to the speaker of the House of Representatives, the report made to him by Professor S. Homer Woodbridge, of the Massachusetts Institute of Technology, on the plans for the new central power station for a number of the government buildings at Washington. The purpose of the new station is to supply heat for properly warming the buildings in cold weather, and to supply power for all purposes, including lighting, pumping, elevator service, mechanical work of all kinds, ventilation, etc. Also to remove and dispose of all steam boilers and engines of every kind, and all electric and other power generators now in the several buildings.

The report takes into account the following existing buildings: White House, Treasury Department, State, War and Navy Departments, Winder Building, Court of Claims, Washington Monument, Bureau of Engraving and Printing, Post Office Department, Smithsonian Institution and National Museum, Army Medical Museum, and the following new buildings now under construction: Municipal Building, Department of Agriculture, National Museum—practically thirteen buildings in all. The Smithsonian and old National Museum, being already connected mechanically, are treated as one. The projected Hall of Records, west of the State, War and Navy Building, has not been included in the estimates because not yet definitely authorized by law, but it may readily be connected to the central station plant when constructed.

The nine buildings of the executive group in present use contain seventy-three boilers, aggregating some 4,500 nominal horse-power, under which are burned annually from 20,000 to 23,000 tons of coal. The buildings are furnished with engines, generators and steam pumps, approximating, in the aggregate, 2,500 horse-power. There are employed in connection with this segregated system 145 attendants in various capacities.

To these boiler, fuel and attendance figures, relating to the buildings now in use, must be added those pertaining to the equipment and operation of three large projected plants, if the isolated method of equipment and operation is extended to the new Municipal, National Museum and Agricultural buildings, making a probable total of eighty-five boilers, burning some 35,000 tons of coal annually, 3,500 horse-power in engines and other mechanisms, and 190 employés for operating the twelve segregated plants.

The principal item of cost to be incurred in any execution of the proposed plan of centralization is the interest chargeable to the investment required for—

1. The purchase of land; the building of a power-house suitable in proportions and arrangement for the proposed use and also appropriate in architectural design for a place among the monumental buildings it is to serve; the purchase of boilers and accessories of furnishment for the building, including provision for coal storage and for coal and ash-handling, engines and generators, electric storage battery, condensing and economizing apparatus, traveling cranes, and other apparatus, switchboards and electrical outfit, and mechanism for heat distribution.

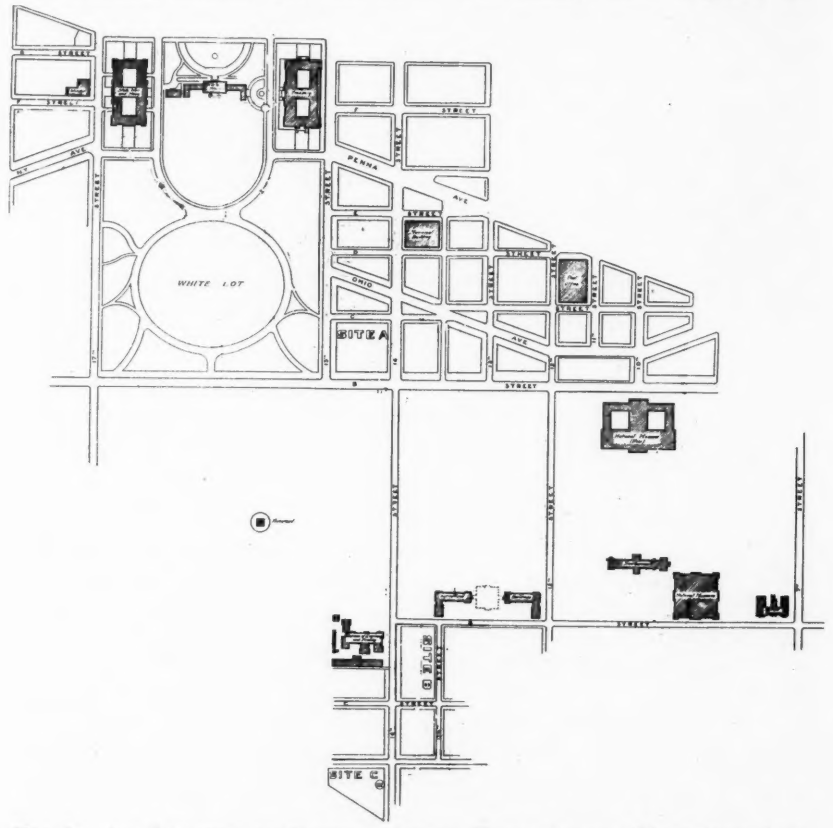
2. The connection of the several buildings with the central plant, by a piping system for the carriage of heat and by electrical conductors for the transmission of electric energy for power and lighting purposes, and the protection and insulation of such piping and cables.

3. The modification of apparatus already installed or in use in present buildings; the grafting of the piping and wiring systems of the present buildings onto the new system of distribution and return.

To such items must be added the losses on discarded material in present installations and which can not advantageously be incorporated in a central power-house installation; any increased expenses of operation, maintenance and repair over similar expenses incurred with the present segregated installations, and the further expenses incident to losses due to leakage of electrical and thermal energy from connecting cables and pipes between station and buildings.

The leading items of profit due to centralization are the various economies obtainable in the operation of an aggregated plant of modern type. These include:

1. All items pertaining to the purchasing, carriage, storing and handling of fuel, the grade and market price of fuel and the handling and disposal of ashes being considered; (2) the efficiency of the boilers and the increased power value of steam produced because of higher pressures allowable than would be justifiable in buildings occupied by large numbers of employés; (3) the providing of power and lighting and the cost of electrical production and distribution instead of purchasing such current from and with



MAP SHOWING LOCATIONS FOR PROPOSED CENTRAL POWER STATION, WASHINGTON, D C.

profit to a mercantile corporation; (4) the utilization of the usually wasted heat in exhaust steam and in combustion gases; (5) the reduced cost of labor because of the compactness of equipment; (6) the considerable aggregated space which would be vacated and made available for offices and storage or other uses in the several buildings from which boilers, engines, generators and other mechanisms would be removed and in which the storage of coal and ashes would be discontinued; (7) in the abatement of the risks of fires and of the nuisances of smoke, gases, heat, dust, noise and vibration and of other inconveniences and losses incident to boiler work within occupied buildings.

The selection of a location for a central station should have due reference to the location of present buildings and their requirements and to the probable sites and sizes of such future buildings as the plant may be called upon to serve. The location, furthermore, should be favorably situated for easily and inexpensively furnishing fuel to the central station, and for similarly disposing of ashes, and also for obtaining tide-water for condensing-engine purposes.

By the study of available records the centres of balance of both thermal and electric consumption have been determined. Both of these centres lie close to square No. 230, bounded by the streets B and C and Fourteenth and Fifteenth N. W. It was deemed advisable to make a careful study of the entire problem with first reference to a location of the station at that most central and consequently most favorable of all points.

Square No. 230, the location of the highest economic value, is designated as Station A.

The subsidiary reasons in support of the selection are:

The location is accessible by electric tramway, by which the power station may be connected direct with the steam railway and from which the steam railway coal cars may be drawn, preferably at night when passenger traffic is suspended. The tide-water may be brought to the site by piping carried through a large and vacated sewer in the close vicinity, and waste water may be disposed of through the same sewer-way. A large future growth of the plant may be provided for by acquiring the square No. 229, north of and adjacent to 230, and by closing and occupying the short and narrow street between the two areas. Such an extension would accommodate a station building sufficiently large to house a boiler, engine and generator station of three or four times the size required for present demands.

In the proposed station in place of the present seventy-three boilers in twenty or more isolated stations, aggregating some 4,500 horse-power, a central station equipment, which shall include boilers for the three additional and large buildings, may not contain more than ten boilers of 400 horse-power each, all in one boiler room. On an emergency, high-efficiency boilers having a nominal capacity of 4,000 horse-power could be easily forced to a 6,000-horse-power steam output.

The central station, or power-house, located where proposed would be in close proximity to some of the principal government buildings, and should be designed to comport with the architecture which does now or shall in future characterize them.

In the accompanying cross-section of the building the floor of the basement is shown on the same grade with the street, and the spur tramway tracks are carried into that part of the station which will become central by any such enlargement of the building as is outlined. Cars may be run on a level grade into the building, where coal may be dropped into pockets and thence carried by conveyers either to the large storage hold above or else to the boiler-room pockets. Ashes may be carried by conveyers from boilers to storage pits, and raised from the pits by mechanical conveyers to cars. Cars may be run under the engine room, and machinery may be lifted or lowered through the trap-door by the traveling crane. The basement space and height afford ample room for condensers, pumps, piping and apparatus connected with the power and heating systems, and that part beneath the boilers furnishes ample space for the handling and conveying and storing of ashes and for locating and operating the conveying machinery. Between the shown and the prospective boiler sheds is a room for coal storage having the capacity for a fortnight's supply under conditions of average maximum demand.

Provision is made for utilizing the heat of combustion gases escaping from boilers to chimney by means of superheaters and economizers. The boilers should be of a type to safely and economically furnish superheated steam at from 175 to 200 pounds pressure to the square inch.

The central station site, thus tentatively located in the position of highest available working economy and with reference to the largest probable demand for space, is advisably equipped with apparatus and devices for ensuring the fullest economy of installation and operation.

From the engine standpoint, the problem presents its most interesting difficulty. The engine to be harnessed into work of the character in question should be of the simplest type, both as to mechanical principle and to operating mechanism. It should be usable without difficulty as a non-condensing engine, and without waste of steam. It should also be capable of furnishing power with a maximum efficiency under high-vacuum condensing conditions. The modern steam turbine, now emerging from the experimental into the development stage, is better adapted, in the simplicity both of its mechanical principle, and of its construction, to the wide range of exhaust-pressure conditions incident to the method in question than is the high grade, but complex, mechanism of the modern condensing engine.

In regard to thermal transmission the report states that heat may be conveyed from a central station to the buildings of the executive group either by steam or by water. The various advantages and disadvantages of the two systems are discussed and the preference is given to water as the most appropriate vehicle for heat conveyance.

For the purpose of reducing the first cost of installation and also the after-cost of heat loss from pipes, the pipe plan submitted for Station A is proportioned for a working-pressure difference between the feed and discharge sides of a centrifugal pump of 200 feet hydraulic head, or 100 feet propulsion and 100 feet "suction." Such a drop of pressure on the "suction" side of the pump is made practicable because of the hydrostatic head of 122 feet to which the circulating system would be subjected, due to the height "above reference" of the fourth floor of the State, War and Navy Building. Such static pressure would neutralize the "suction" effect of the pump, and, with the pump working on the cooler side of the heater, would prevent any liability of a vapor "break" in the water.

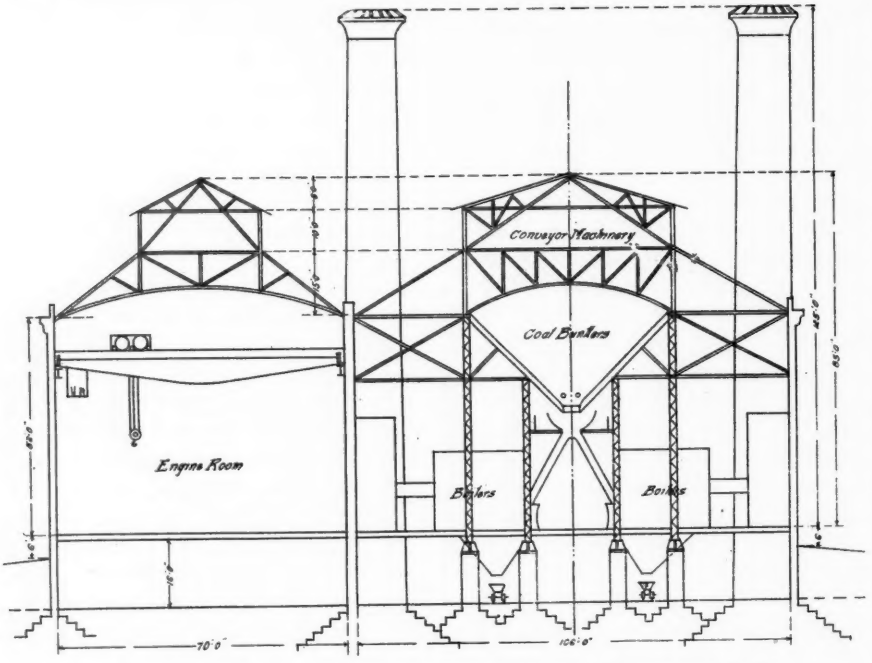
It is further advised that the water be circulated in such manner that in the coldest weather it shall lose not more than thirty degrees in temperature in complete circuit, and that the ratio of the length of time the water may be retained in the buildings to that it shall be in traversing the pipes shall be made as large as practicable.

The maximum quantity of water proposed for the system for the executive group is 11,500 gallons per minute, or,

roughly, 88,000 pounds. The maximum drop in temperature proposed for severe weather is thirty degrees, making the corresponding heat quantity approximately 2,640,000 units per minute. It is computed that the average heat quantity passed into the pipes will be fifty per cent of the above named, or 1,320,000 thermal units per minute, or very nearly 79,200,000 thermal units per hour. With good firing, such steam heat should be produced by the burning of four tons of coal; or eighty tons for the average, and 160 tons for the extreme day of twenty firing hours; a probable total of some 16,000 tons for the heating season.

The estimated heat loss from transmission pipes is 0.25 thermal unit an hour per square foot of pipe surface and for one degree of temperature difference between the pipe surface and the earth temperature outside the walls of the trench, the pipes being embedded in granulated cork. The average water temperature is estimated at 150 degrees, and that of the earth at forty-five degrees Fahrenheit. The average loss per square foot of pipe surface would then become twenty-six and one-half thermal units per hour. That loss per square foot multiplied by the total area of the pipe surface, namely, 64,000 square feet, gives 1,696,000 thermal units per hour as the average loss. This quantity is 2.14 per cent of the heat supplied to the pipe system, and is equivalent to 0.0848 ton of coal per hour, or 2.04 tons per day of the heating season of two hundred days, making a yearly total of 408 tons.

A careful study has been made of the many factors which enter into the complex problem of the transmission of electric power and of current for lighting to the respective buildings of the executive group. The type of current best adapted to serve these buildings as now wired for lighting and as equipped for motors of various kinds for power, elevator, and pump work can be determined only by a correct understanding and solution of that problem.



Cross-Section of Proposed Central Power Station, Washington, D. C.

The adoption of the high-potential alternating-current system would make necessary a change of that current at the buildings into low-potential electricity, for which transforming apparatus would be required. The quality of copper and insulation suited to the two kinds of current, the subdivision of the cables into those for power and those for lighting, the installation cost of transformers, the cost of increased attendance in connection with transforming service, the energy lost in the process of transformation as well as that of transmission, the cost of changing present and costly direct and low-potential equipment already installed in buildings, and of adapting the systems to the alternating current, have proved to be serious obstacles to the use of that type of service. The further considerations of the far greater adaptability of the direct current to all the general purposes for which electricity is used in this group of buildings; of the relative simplicity of the direct current and the reliability of its action; the ready control of as well as the uniformity of the intensity of the current furnished by it for incandescent lighting, affecting both the luminosity and life of lamps—that most important part of the entire electric service—have contributed to the argument in support of the superior fitness of the direct-current service to the general use and conditions prevailing in the buildings of the executive group.

The investigation has rendered it evident that for the average transmission distance and for the average transmission load, and for the nature of the work peculiar to this case, the low-potential direct current is preferable to the high-potential alternating current for power and light distribution from the central station A.

The land required for a central power plant building is in any event likely to become government property, as will also much more, if not all the land lying north of the Mall, and west of the present botanical gardens and south of Pennsylvania avenue. In the following estimate, it is therefore assumed that the lot designated as "Site A" will eventually become government property, and its cost is not charged to the account of the central plant.

The estimated cost of Station A is as follows:

Building for twenty 400-horse-power boilers and corresponding engine, generator and coal-storage capacity, 176 feet by 250 by 80 feet = 3,520,000 cubic feet, $450,000.

Proportion of building chargeable to proposed immediate plant, $225,000.

Ten boilers, 4,000 horse-power, at $14 per horse-power, $56,000.

Economizers, at $5 per horse-power, 4,000 horse-power, $20,000.

Boiler piping, feed-water heaters, pumps, etc., $18,000.

Coal and ash-handling machinery, $15,000.

Traveling crane, $7,000.

Engines and generators, switchboard, condensers, etc., 2,350 kilowatts, $204,450.

Electric storage battery, $120,000.

Rotary pumps, tank, supplementary heaters, etc., $3,000 per 1,000 gallons per minute, 11,000 gallons, $33,000.

Piping, pumps, and motors for supplying condensing water, $2,900.

Trenching, transmission piping, insulation, $91,590.

Changes in buildings for heating by water, for entrance, and for connecting

distributing mains with present or altered heating systems, $60,300.

Electric cables, conduits, entrance to buildings, etc., $195,300.

Changes in buildings for lighting and power, including elevator equipment, service pumps, etc., $118,500.

Total cost of instalment, $1,173,040.

Installation expenses, per annum, $57,555.

Operating expenses, per annum, $211,855.

Cost of operating equivalent segregated plant, $327,677.

Total operating costs and investment charges, aggregated plants, $211,855.

Annual profit in aggregated plants, $115,822.

In addition to Station A, two other locations for the station were considered, known as "Site B" and "Site C."

"Site B," opposite the Bureau of Engraving and Printing, was chosen as the best location to be given a power plant on the south side of the Mall.

If located at "B," the character of the building, in matters of material and of architectural features, would admit of a lower construction cost than at "Site A." The value of this item of saving may be placed at approximately $70,000 for the proportional part of the building chargeable to present requirements.

The piping required for the transmission of heat by water and to the Post Office and Bureau of Engraving and Printing by steam for drying, etc., from this station to the buildings would be $131,850, and would be $22,950 greater than for Station A.

The carefully estimated costs of electrical cables and conduits for the distribution of power and light from this station to all the buildings of the executive group would be $288,000, as against $195,300 for "Site A." While, therefore, there might result a possible saving of $70,000 in the power plant building, such saving would be offset by the difference in costs in the transmission systems, amounting to $20,850 for the heat pipes and trenches, and to $92,700 for the electric cables and conduits, or to a total increase of $43,550 in the cost of installation. The loss in operating costs in heat loss would be increased as the lengths of piping are greater and as pipe surfaces are larger. Those surfaces are in a ratio of 1 for "Site A" to 1.42 for "Site B." The increase in heat loss would be equivalent to 200 tons of coal per year.

The cost of obtaining condensing water from the Potomac would be greater for "Site B" than for "Site A." In the matter of piping, the increase would be $1,400, and that in power required during the summer months, when exhaust steam can not be utilized, would be equal to some fifteen horse-power for twenty hours per day; or, for the one hundred and thirty days, the saving would be approximately the cost of twenty-four tons of coal.

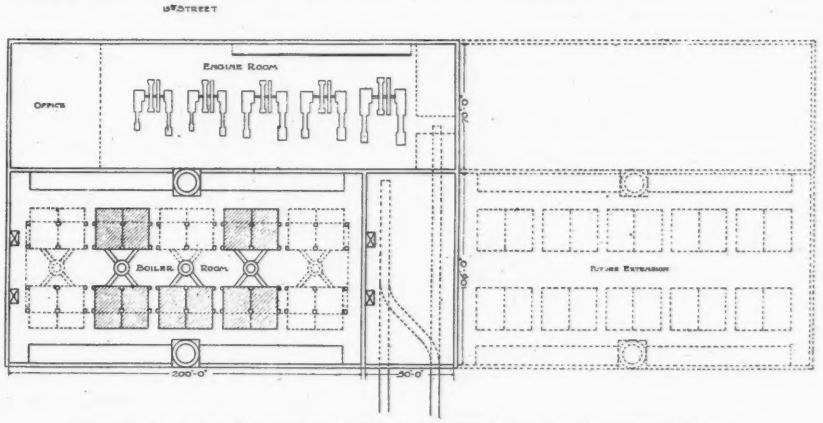
An extreme location for the station, known as "Site C," would be at the foot of Fourteenth street, on the bank of the Potomac. The principal advantage to be claimed for this location is the distance of "smoky chimneys" from the buildings served and the city in general.

Possibly the character of the building at that site might be so simplified, in stripping it of all ornate features and constructing it of cheap but substantial material, as to reduce costs $50,000 below those of a building suitable for "Site B," or $120,000 below those noted as probable for "Site A."

There would be required a further total of 2,200 running feet of twenty-inch pipe and trenching, costing $16,500 additional.

The longer distances from this site to the buildings of the executive group would make necessary a hydraulic head, or pressure, of 122 feet propulsion and 122 feet "suction" for circulating water through the transmission system, a pressure so great as to be of questionable safety in application under existing conditions of static head. The remedy would be in larger and more costly main pipelines.

The most economical production and distribution of electrical current for power and lighting from this station would make it advisable to employ a dual method of high-potential alternating current for lighting and high-potential direct current for power service. The use of high-potential circuit so reduces the sizes and costs of copper conductor wires as to make the expense attending the installation of cables and conduits $30,050 less than that for the corresponding installation for electrical distribution from "Site A." The reduction includes the cost of the required transformers. Additional changes within the buildings would be required, to adapt the power and lighting systems to the changed currents, at a cost of $35,600. Likewise, a change in the number and capacity of the power-house electrical generating units would be made necessary, such change eliminating the storage battery and increasing the engine and generator capacities, and reducing costs of power-house installation $41,250.



GROUND PLAN OF PROPOSED CENTRAL POWER STATION, WASHINGTON, D. C.

The costs of the complete electrical installations, excluding buildings and boilers and the boiler-room piping and furnishing—all of which would be required for heating—are as follows for the sites "A," "B," and "C," the storage battery being included for sites "A" and "B," and the service for the Bureau of Engraving and Printing being included and omitted as indicated:

	Site A.		Site B, with Bureau.	Site C, without Bureau.
	With Bureau.	Without Bureau.		
Power-house equipment	$303,250	$280,500	$303,250	$243,250
Transmission system	195,300	162,650	287,800	132,600
Changes in building equipment	118,500	118,500	118,500	154,100
	$617,050	$545,650	$709,750	$539,900
Estimated total annual saving	84,211	59,902	77,665	55,836
Per cent return on investment	13.70	10.60	10.90	10.30

The report concluded with a summary of the advantages and disadvantages of the central station and the various sites, and a recommendation that a central station be immediately erected on "Site A."

FUEL ECONOMY IN STEAM POWER PLANTS—III.[1]

BY WILLIAM H. BOOTH AND JOHN B. C. KERSHAW, F. I. C.

To produce superheated steam has proved more difficult than might be anticipated, owing to the variable conditions of the furnace. To prevent superheater tubes burning away, steam is often made to rush through them at a high frictional velocity, whereby its pressure being reduced twelve, fifteen and even twenty-five pounds, much of the gain of superheating is sacrificed. In separately fired superheaters no tube will stand a temperature above, say, 1,400 degrees Fahrenheit. Few will stand more than 1,000 degrees Fahrenheit to 1,200 degrees Fahrenheit. But a furnace worked with any regard for fuel economy has a temperature of waste gases of 2,500 degrees Fahrenheit or 3,000 degrees Fahrenheit. All separately fired superheaters that do not possess a system of water control and temperature reduction are made safe against the high furnace temperature by an enormous inlet of cold air through the grate or door, or through special air openings. As the superheater must inevitably reject its gases at, say, 700 degrees Fahrenheit, the surplus air is all rejected at that high temperature, and a large proportion of the advantage of superheat is lost. The separately fired superheater should abstract the surplus furnace heat in a rational manner, and this is best done by means of a shield of water between the furnace and the superheater. The advantage of the water protection shield in advance of the superheater tubes is that the feed-water for all the boilers of the set may be passed through the tubes and raised to the boiler temperature. The advantages of thermal storage are thus secured, for these are chiefly confined to the high rate of evaporation at which a boiler can be forced when fed with fully heated feed-water. Not only is priming reduced or prevented, but the whole working of the boiler is rendered more efficient.

To secure superheat economically, it is first necessary that the steam-way through the superheater tubes should have an area equivalent to twenty-five to fifty per cent in excess of the boiler steam pipe. The ordinary small-tube superheater, if given so much equivalent area, would not then cause the serious loss of pressure it now causes, but it would burn away more rapidly than it now does. In Germany, where, probably, small tube superheaters have a larger allowance of area, this burning out does occur rapidly, but it is said to pay to burn out tubes rather than to sacrifice so much pressure. There is no need to do either where water control of superheat is adopted, as proved by six years of steady work without deterioration. But a first-class water-controlled superheater, though it may last indefinitely, will cost double or treble as much as an ordinary uncontrolled superheater. In return for this, it will supply feed through the water-control pipes at full boiler temperature, thus increasing the efficiency of the boiler considerably as well as the output.

In the manufacture of steam fit to be used in an engine, economy demands its production in distinct stages. The water, duly purified, is first raised to the temperature of condensation by the exhaust steam. This may be, say, 100 degrees Fahrenheit. It is next raised to a temperature of, say, 250 to 300 degrees or upward, by means of the residual heat of the waste gases. If still below boiler temperature the feed-water may be raised to that temperature by the water-control apparatus of the superheater, and in separately fired superheaters by the water screen which protects the superheater pipes from too direct fire action. The boiler then comes into action and adds heat to the feed-water. All this heat ought to become latent. None of it ought to go toward raising feed temperature. Indeed, in the absence of the last-named stage of feed heating a live steam heater should form this stage.

The boiler should produce steam which contains the maximum possible amount of heat per cubic foot, and is capable of performing work in the smallest possible cylinder. Unfortunately for economy cylinders are made of material which exchanges heat with the steam, particularly if wet, and, despite all precautions, steam enters the cylinder loaded with water and can not lose heat without liquefaction taking place. If superheated its water contents are evaporated and its volume is increased. It can travel faster because its molecular kinetic energy is greater. It loses nothing at drains, and though it loses temperature it does not become wet so long as any superheat continues. It furnishes heat to the interior walls of the cylinder and reduces those exchanges of heat which increase steam consumption by twenty to fifty per cent. Little or no superheat need remain at the point of cut-off, and there is then contained in the cylinder the greatest amount of heat possible at the given pressure. For the first cylinder of a compound engine steam should be superheated. The superheating of the steam between the cylinders is a matter of dispute. It ought to be economical, and, if it fails to be so, the cause is perhaps connected with the absence of drainage of the receiver. Engineers who have intermediate receivers capable of reheating would perform a service if they would make commercial tests under the two conditions during a series of alternate weeks.

Superheating should therefore be considered as one of the final stages of dry steam production, the actual final stage being the cooling of the steam to saturation temperature by means of the heat-absorptive effect of the cylinder walls. Superheating is necessary to economy because cylinders are not adiabatic. With superheated steam, cylinders are nearer to adiabatic conditions. The economy from a given expenditure upon superheaters is to be found by suitably equating first cost charges, cost of stoppages to renew tubes and maintenance generally with the economy of fuel that superheat will secure. There are only two classes of superheaters, the cheap apparatus without control and the apparatus with water control, of which class there is only one representative. Comparison would be therefore out of place by the authors.

THE WASTE GASES.

The temperature and chemical composition of the waste gases passing from every large boiler plant ought to be regularly ascertained, the work being carried out by a man specially trained in technical gas analysis. The absence of smoke is no guarantee that combustion is being carried out in an economical manner, and only by constant testing of the exit gases can one be certain that the fuel is being burned without undue excess of air. The significance of air excess becomes manifest when one considers the following figures:

With gases containing only four per cent of CO_2 and a chimney temperature of 400 degrees Fahrenheit, 4,380 British thermal units are lost for every pound of fuel burned, *i. e.*, 32.4 per cent of the total heat value of the fuel. It may be objected that this percentage of CO_2 is much lower than that present in the flue gases of electricity works, but the authors believe that this percentage is not exceeded in many works where no special attention has yet been given to this question and where no CO_2 testing apparatus has yet been installed. In nearly every

[1] A paper read before the Institution of Electrical Engineers, London, England, January 12. The first part appeared in the ELECTRICAL REVIEW, February 25.

case where automatic or other CO_2 testing apparatus has been purchased and used the authors know that all the earlier tests have been under five per cent of CO_2, proving that under the every-day conditions of work obtaining in these plants unduly large volumes of air were being admitted. Where no economizer is installed the loss of heating power is even greater, for the gases then pass to the chimney at a temperature of from 600 degrees Fahrenheit to 700 degrees Fahrenheit, and the heat losses rise to 6,570 and 7,665 British thermal units, or to between forty-eight and fifty-six per cent of the total heat value of the fuel.

Taking now the case where the boiler plant is under scientific control and by constant testing the percentage of CO_2 in the exit gases has been raised to twelve per cent, the loss of heat with chimney gases at 400 degrees Fahrenheit is reduced to 1,540 British thermal units, or to 11.4 per cent of the total heat value of the fuel. In the one case, only between forty-four and sixty-eight per cent of the heat can possibly be utilized, while in the other 88.5 per cent of the thermal value of the fuel may be converted into useful work—either in the boilers or in the feed-water apparatus. Engineers would therefore be wise to give most careful attention to this question of excess air supply to the boiler furnaces, and to make proper provision for the constant sampling and testing of the exit gases.

Having drawn attention to the great importance of this subject, the authors do not propose to describe all the various apparatus and methods to be used in sampling and testing the exit gases. A few general remarks on the subject may, however, prove of value as a guide to practice in this matter. The examination of the exit gases should cover the following points: (1) color and appearance, (2) draught and temperature, (3) chemical composition. Daily tests should be made for these on each boiler of the plant, and in the main flue and at the base of the chimney. To facilitate this work, special sampling and observation holes must be constructed at the various required points in the brickwork of flues and boiler settings by use of thirty-inch lengths of wrought-iron pipe, one and three-fourths inches inside diameter. The pipes should have a flange screwed on the top, and should be set in the brickwork with cement. When not in use for testing purposes, they must be closed with an iron bolt or with cotton waste. When new boilers are installed, these sampling holes should be left when setting the boiler.

Iron pipes are not to be recommended for sampling flue gases, since such pipes corrode and become choked. Many low tests of CO_2 are, in the authors' opinion, due to the use of iron pipes for sampling purposes. Three-foot lengths of hard potash glass tubing three-eighths of an inch in external diameter should be employed. This glass stands a very high temperature without softening or fusing, and does not combine with oxygen at a red heat.

These glass sampling tubes must be removed from the flues when not in use for sampling purposes, and cleaned with a tube brush from adhering dust and soot. Fixed filters for retaining soot and dust are also bad in practice, since, if small, they speedily get stopped up, and, if large, they hold a large volume of gas and prevent the tested sample from being truly representative. They also increase the dangers of air leakage, and are to be condemned on that account. Lengthy lines of iron connecting pipes are also not to be recommended. The sample of gas from boiler flues ought in fact to be collected as near as possible to the flue itself, and only glass and rubber should be employed for connecting the sampling apparatus to the flue. Many of the CO_2 test results now being obtained are, in fact, of dubious value, owing to the neglect of these elementary precautions in sampling.

With regard to temperature determinations in the flues and at the chimney, these may be made either with a water pyrometer—a high temperature mercury thermometer—or with one of the various forms of electrical resistance pyrometer.

For ascertaining the heat inside the combustion chamber of the furnace one of the photometric methods should be employed. The theoretical temperature attainable in the furnace by the combustion of coal lies between 3,500 degrees Fahrenheit and 3,700 degrees Fahrenheit; the maximum attained under practical conditions is about 2,800 degrees Fahrenheit. The temperature of the exit gases should not exceed 400 degrees Fahrenheit when chimney draught is employed; when artificial draught apparatus is installed the exit gases may be reduced to atmospheric temperature, if this is practically possible.

Draught tests can be made with any form of water-gauge reading to one-sixteenth of an inch. A portable U-tube gauge, that can be carried about, may be employed for testing the draught in individual boilers, but it is well to have a fixed draught gauge at the chimney base and on the main flue. Here again a glass tube is to be preferred for connecting the gauge to the flue. This tube should be removed at short intervals and thoroughly cleaned and washed.

If automatic recording apparatus be installed for taking the CO_2 temperature, or draught tests, glass tubes should be employed whenever possible for the necessary connections to the flues, and all the precautions already named must be taken to keep the tubes clean and free from deposits. The apparatus must be placed in all cases as close as possible to the flues from which the samples of gases are collected; otherwise the volume of stale gases in the connecting pipes and air leakage at the joints will cause error. When water jet air pumps are employed to draw the sample gases through the apparatus, a separate water tank with a filtering attachment should be used for supplying the pump, otherwise stoppage of the apparatus is likely to occur at inconvenient times by dirt, etc., collecting in the jet of the pumps. The results obtained by all recording instruments require checking occasionally by independent tests with other apparatus.

DRAUGHT, ETC.

A good draught is only an aid to economy when other conditions are good. Too good a draught must not be employed with a thin fire, for it will cause too large an influx of air. Fuel of a large size will stand a powerful draught, but also demands a thick fire. With a good draught it may occur that the closing of the damper will not only check the rate of combustion of the fuel, but will cause smoke by reducing the indraught of air through the door grids. Boilers are thus best partly regulated by dampers which close the ashpits, rather than altogether by dampers in the flues. The ashpit damper properly applied and used will prove an aid to economy.

The production of a chimney draught with a temperature of waste gas, say 300 degrees Fahrenheit above atmospheric temperature, points to a consumption of heat about one-ninth of the total heat produced in the furnace. This fact points to a minimum air supply, which implies maximum furnace temperature and best efficiency of heating surface. Under normal conditions, however, from twenty to thirty per cent of the total heat of coal goes up the chimney. It is claimed that a fan draught can be produced with about one per cent of the total engine power, and that the use of a fan must

therefore effect a great fuel saving. A fan will not save fuel unless it enables this to be burned more efficiently as above. A fan draught will give economy if by its aid a flue feed-water heater can be installed to reduce the excessive temperature of the flue gases. To use full effect heaters a high and expensive chimney is needed. Fan draught must therefore be considered in the light of enabling an economy in chimney construction to be effected, and full use made of feed heating apparatus. It is also useful as enabling boilers to be forced to rapid steam production, and presents itself as a safeguard against sudden load in lighting stations and as a means of surmounting the load peak without excessive boiler plant. Fan draught is thus useful as a means of reducing capital expenditure on chimneys and boilers by promoting the rate of combustion of fuel at higher rates per unit of grate area. It enables the thickness of the fire to be regulated in better accordance with the fuel size and generally promotes elasticity. It is also useful in enabling the hot gases to be compelled to pass over all the heating surface, and baffles may be introduced that would otherwise be perhaps too great a hindrance. Its economy in other cases appears to demand the fullest practicable reduction of the calories in the exhaust gases by feed heaters, which in large stations may well be in two stages, and perhaps by air heaters for furnace supply.

When, however, it is attempted to utilize the last remnants of waste heat let it be remembered that we are, so to speak, working near the lower end of the curve of expansion, and that for each item picked up with one hand we are paying out with the other. All attempted economies, therefore, may cease to be commercial economies before they cease to reduce fuel expenditure per kilowatt.

CONCLUSIONS.

Finally, may the authors point out that the best results can only be attained if scientific methods of control are employed in relation to feed-water fuel, waste gases and draught. Automatic apparatus for testing flue gases or any other product can never take the place of a trained chemist; for an automatic apparatus demands not less, but more skill in its control and management than ordinary apparatus, if the records obtained by it are to be of permanent value. The results now being obtained by CO_2 recorders in many electricity works are, in the authors' opinion, of doubtful value, owing to the lack of trained expert assistance in their management.

Automatic apparatus of all kinds is, we admit, of great service, but not in the direction popularly supposed. It enables one skilled and efficient man greatly to increase the number and extent of his duties, and practically to treble or quadruple his efficiency; but it does not, and can not give accurate and valuable records when placed in the hands of untrained men.

It is remarkable that engineers, after their long experience of automatic stoking appliances, should imagine that automatic testing apparatus will achieve the impossible. In each case the best results can only be attained when the automatic apparatus is under expert supervision and control; and for testing apparatus, the expert control required is that of a specially trained and skilled chemist. In the working of a large modern boiler plant the chemist is, in fact, as much in place as in a chemical works, and the recognition of this truth will undoubtedly promote the economical working of such plants.

The following words, written over sixty years ago by the pioneer in the movement to obtain more scientific use of coal and fuel in steam raising (we refer to that remarkable man, C. Wye Williams), are still applicable to the position in this year, 1905, and there are a few present who would guess that they were a quotation from a book entitled "The Combustion of Coal," published in the year 1841 in Liverpool, and dedicated to the proprietors of the City of Dublin Steam Packet Company:

"It may be asked how it has happened that hitherto the smokeless combustion of fuel has not been effected. I answer, because the chemistry of combustion has been neglected, not in the laboratory, but in practice; and because the construction of our furnaces has been too much left to those who know little of the chemical properties of the materials which are consumed in them."

RULES FOR SAMPLING FUEL.

As each barrow load or fresh portion of fuel is taken from the pile or store heap, a count is kept of the number used, and the whole contents of each tenth or twentieth barrow or portion are placed on one side, in a cool place, under cover. Care must be taken that the barrow or portion selected for the sample does not contain an unfair proportion of lumps or smalls.

At the end of the day, or period for which the sampling is to be carried on, the heap of fuel obtained for sampling purposes, as described above, is transferred to a sampling plate, and the larger lumps are all crushed down to walnut size. Should no sampling plates be available, four of the iron plates used for covering man-holes and boiler flues may be utilized to obtain a hard, clean surface on the floor of the boiler house, and the crushing down of the sample may be carried out on these plates with any heavy and flat lump of iron at hand. The heap of fuel, after this first crushing, is thoroughly mixed by turning over and over with a shovel. The heap is then flattened down, two lines are made across it at right angles with the edge of the shovel, and two of the four opposite sections are selected to form the reduced sample. The lumps in this are again crushed, the sample is again mixed, and the quartering operation repeated, until about eight pounds or ten pounds of fuel only remain, with no lumps that will not pass through a one-fourth-inch sieve. Two one-pound tins with ordinary or patent lids are filled from this remaining heap of fuel, after thoroughly mixing the same with the hands or with a small shovel. One of these tins is to be sent per parcels post to the fuel expert for analysis; the other is to be kept for reference in case of dispute.

Electric Plant in Formosa.

United States Consul Fisher, writing from Tamsui, Formosa, states that, in the early part of 1904, the engineering department of the Formosan government commenced work on the construction of an electric plant on the upper course of the river Shinten, about ten miles to the southeast of Taihoku. Water power will be used, and will be supplied by a canal cut from the upper course of the south branch of the Nansei river, which flows down the mountains in a series of cascades. The length of the canal is 7,200 feet. The width of the canal at the bottom is from eleven to twelve feet, and the discharge will be 250 cubic feet per second. This is intended to give 1,000 horse-power, but 650 horse-power will be sufficient for the present requirements.

The plant will be equipped with two McCormick turbines, each of 384 horse-power and 450 revolutions per minute; two three-phase Westinghouse alternating-current generators of 250 kilowatts capacity, at 11,000 volts and 450 revolutions per minute; and a McCormick exciter turbine of forty-nine horse-power, together with a Lombard governor. The plant will supply current for lighting the cities of Taihoku and Tamsui, and also for an ice plant, sawmill and other works in the first-mentioned city. The cost, including the construction of the canal, will be approximately $175,000.

TRANSFUSION (ELECTRICAL)—A STUDY OF THE THEORY AND PHYSIOLOGICAL EXPERIMENTS AND THERAPEUTICAL APPLICATION OF CURATIVE AGENTS THROUGH THE TISSUES BY STATIC ELECTRICITY.[1]

BY JAMES J. EDMONDSON, M. D.

Electrostatic currents while passing through the body can be made to carry along medicinal or antiseptic substances.

The joint action of static electric currents of high tension with an agent which is transferred by the action of the currents produces a permeation of all the tissues in the path of the current.

In electrolytic processes not only chemical changes are brought about, but there is also a wandering of molecules. In decomposing dilute sulphuric acid by a current of one ampere the cell in which this experiment is made contains a membranous diaphragm. After several hours the concentration of the acid on one side of the membrane shows the transference of acid by the electric current. This wandering of molecules is easily explained in accordance with the well-known theory of electric osmosis. By this the fact is established that electric currents cause a transference of the molecules of chemical substances. The human tissues may be considered as acting like the membrane in the above experiment. An antiseptic is transferred in an analogous manner to the seat of disease.

A chemical decomposition of the antiseptic does not take place. The high-tension currents merely act as a vehicle or means for conveying or producing a flow of the agent to the seat of disease.

PHYSIOLOGICAL EXPERIMENTS.

For the purpose of determining positively that electrostatic currents can be used to carry agents through the tissues of the body, a large, powerful, specially constructed static machine was used.

Preparations of iodine, mercury, and formaldehyde, which had been made after a great deal of experimentation, were employed in these physiological experiments.

Several guinea pigs were treated with these preparations and upon subsequent tests, involving the viscera, permeation was evident, and in goodly proportion.

Proof has thus been obtained that electric transfusion of medicaments is certain and safe.

This means a revolution in therapeutics, for the stomach can be relieved of a function which does not belong to it. It is therefore possible to feed the patient abundantly—a great factor in combating many diseases.

Any disease that can be cured by the absorption of drugs taken into the stomach can be cured more rapidly and safely when the medicants are carried to the seat of the affection by transfusion (or electric osmosis), and many morbid conditions that can not be reached by agents taken into the stomach can invariably be medicated by this method.

The method is especially applicable to affections of a microbic origin. It has been used very successfully in the treatment of tuberculosis. The results of the treatment are: rapid diminution of the symptoms, the cough, and the bacilli in the sputum; nearly instantaneous cessation of the fever and nightsweats; and, as a further consequence, a quick recovery of strength and return of sleep and appetite.

It is remarkable how easily and in what a short time children can be benefited by this method in tuberculosis.

An important feature is found in the circumstance that, as the remedy can be applied directly to the seat of the disease in any part of the body, it will leave the stomach entirely unaffected and unmolested by medicaments; so that the stomach is able to perform its function of nutrition, so important to maintaining the strength of the patient and facilitating the cure.

As a secondary action of the electric currents it may be mentioned that, besides their healing effect, they are very useful in stimulating and vivifying the organism and exhilarating the patient.

We can not expect the cure of tuberculosis from the internal medication with so-called specific remedies—such as creosote, guaiacol, or raw meat, juice of meat, etc.—which are employed in many different ways, according to circumstances, climate, nor to the confidence put in them, all these remedies having no effect whatever on the real cause of the disease. In reality, our means of fighting against tuberculosis have, heretofore, been reduced to climate, good hygiene, and suralimentation.

Inasmuch as it is accepted that tuberculosis is caused by the activity of the "bacillus tuberculosis," it follows that, if the bacilli in the lungs could be destroyed without injury to the patient, a certain means of curing the disease would be found. In order to render antiseptics useful and effective, a process is necessary by means of which minutely small quantities of the antiseptics can be rendered effective, and as this can not be done with the antiseptic alone a joint action of the antiseptic with another agent aiding in the destruction of the bacilli is requisite to the solution of the problem. The anatomy of a tubercle shows that by its own growth it throws out a wall of connective tissue around itself which is utterly impregnable to medicaments borne by the circulation.

Formaldehyde is a true antiseptic, but pure formaldehyde coalgulates albumin and could not be passed directly into the blood, as it would coagulate the blood and cause death by forming thrombi.

Formaldehyde can be passed into the lungs through the tissues by means of static currents of electricity and the bacilli thereby destroyed.

In order to be convinced of this, one has merely to consider the four operations which compose the method as now employed.

The first operation consists in disinfecting the affected parts of the lungs by means of formaldehyde forced through the pores of the skin. The second has for its object to incite the pulmonary circulation by means of metallic brushes, containing a solution of formaldehyde in special doses. The third serves to produce a cutaneous counterirritation (derivation) by means of the electric current; and, last, the fourth aims at disinfecting the throat and lungs by inhalation during action of the electric current at high tension, the air being charged with formaldehyde.

It may be taken for granted that tuberculosis in all its stages may be treated successfully by the transfusion method.

There have been many surprises at the results obtained with patients who seemed to have passed beyond the point where any help could reasonably be expected.

It is to be hoped that those suffering from this disease can be treated while in the first stage; then they should all be cured.

There have been cases of miscellaneous character treated by transfusion with evident success, but thus far the work has been principally in connection with tuberculosis.

The results of a large number of cases of tuberculosis under this treatment were very satisfactory, and point to a prospect for curing the greater percentage.—*Medical Bulletin.*

[1] Abstracted.

A telephone service between Sasebo and Tokio, Japan, a distance of about 1,000 miles, has been completed. It is reported that the service will be inaugurated in a few days between Sasebo and Moji, Hiroshima and Tokio.

Electrical Notes from Europe.

By Our Special Correspondent.

A HYDRAULIC plant is now in operation for supplying the locality of Bellegarde, which is situated not far from Geneva, Switzerland. It uses a high fall on the Rhone, about five miles from the lake. The plant has been installed by the Société des Forces Hydrauliques du Rhone, and uses Brown-Boveri machines of the three-phase type. At present there are eight alternators in the station and eight exciters, each machine being connected to a separate turbine. A fifty-foot head of water is obtained. The water is brought by a canal cut in the rock and by penstock. The turbines, of the Francis type, furnished by Escher, Wyss & Company, run at 114 revolutions per minute in the case of the alternators, while the smaller ones for the exciters run at 450 revolutions. The alternators have capacities ranging from 900 to 1,500 horse-power. They have a horizontal fifty-pole field, revolving inside a fixed armature ring of the slotted type. Current is furnished at 1,000 or 2,000 volts to different industries in or near Bellegarde.

Among the new tramway systems which have been lately installed may be mentioned a very complete and modern system in the city of Neuchatel, Switzerland. The company which now operates the electric tramways was formed by the fusion of the steam and the animal traction companies. Current is supplied at 580 volts from the city electric plant, but two of the lines are arranged so that they can take current from the hydraulic station at Clees. The system, as now laid out, includes five different lines, which have a total length of twenty miles. There are some very steep grades on these lines. All lines but one use a nine-millimetre overhead wire. One of the lines employs an octagonal wire of 100-square-millimetre section. The lines are supported on iron poles within the city and on wood poles outside the limits, by means of the usual cross-wires, or rosettes are used in other cases. At present there are forty cars running on the system, including ten trailers. There are also three trailers which are fitted out as postal cars. A number of ballast cars and a snow-plow complete the outfit. Most of the mechanical parts of the rolling stock have been supplied by the Compagnie de l'Industrie Suisse, of Neuhausen. Different varieties of cars are used on the lines. Most of them have two motors of eighteen to twenty-five horse power with reduction gearing of 1:4.5. Some cars are forty feet long and are equipped with forty-horse-power motors built by the Oerlikon Company.

Electric motors have been very successfully applied in a large dyeing and calico-printing establishment in the north of Italy. The plant is located at Novara, in the neighborhood of Milan, and is operated by the Stampená Lombardia. Power for the motors is taken from a hydraulic plant at Fars, which is situated some twenty miles from the works upon the Quintino Sella river, which is a branch from the great Cavour canal. The hydraulic plant is equipped with Oerlikon machines, which are driven by vertical turbines. The latter are built for a small head of water and a large output, as the fall is less than ten feet. The two turbines are connected with the dynamos by bevel gearing and cable-belt transmission, the latter consisting of ten cables. The turbines, of 250 horse-power each, make thirty-three revolutions per minute and drive the alternators at 500 revolutions. The alternators give 5,200 volts, three-phase current at fifty cycles. An exciter is coupled to each alternator. The high-tension line from the hydraulic plant follows the canal to the Milan-Novara railroad. The line is mostly overhead. At the Novara works the voltage is lowered to 400 volts by two transformers of 180 kilowatts each, which are contained in a masonry tower. The secondary switchboard is placed on the ground floor of the pavilion, and there is also a steam engine and a rotary group which serve to supply current when the hydraulic station is stopped for cleaning the canal. The rotary group consists of a sixty-five-horse-power, three-phase motor direct-coupled to a generator. It furnishes the lighting current for the works. A pulley is placed on the shaft between the motor and generator so that an engine can run the latter when desired. The motors in the main establishment are used to operate different machines, especially the machines for printing upon fabrics.

A new type of postal automobile has lately been adopted in Milan. It runs between the different post offices and collects the mail from the letter boxes. The car is equipped with an electric motor and battery. It is of somewhat large size and is divided into two parts. The platform in front contains the place for the motorman and the controlling apparatus. The inside is fitted up for sorting the mail and is well ventilated, lighted and heated. When passing from one letter box to another an employé sorts and stamps the letters, then forms them in packages which he passes to a second employé. The latter places them in compartments for each of the letter-carriers so that they can be rapidly distributed in the different quarters of the city. The new system effects a great saving in time, and it is expected that it will be used in all parts of the city before long.

Among the recent news relating to aerial telegraphy in Great Britain, it may be mentioned that the postmaster-general has made an agreement with the Marconi company by which the telegraph offices in the United Kingdom will be prepared to transmit messages to and from the aerial telegraph stations on the coast, to be sent between such stations or to vessels at sea. These telegrams will be forwarded at the sender's risk, and the rate is said to be $0.13 per word with a minimum amount of $1.56 per message. It is also reported that the Turkish government has now made a combination with the Siemens & Halske firm, which has a branch at Constantinople, to represent the aerial telegraphy interests. The agreement has in view the erection of two stations at a distance of 400 miles apart at the expense of the Turkish government. One of these posts will be located on the island of Rhodes and the second will be placed at the port of Derna, on the North African coast. In France two stations have now been opened on the coast, one at Porqueralles, and a second at Ouessant. They are prepared to send public messages. At the same time different kinds of new apparatus will be tried, as the government is not disposed to adopt any particular system of apparatus definitely before the International Aerial Telegraphy Congress is held at Berlin next spring. This congress is expected to decide many important questions, especially the use of a uniform type of apparatus which will allow all the different stations and vessels to signal to each other.

The Dolter system of surface contact,

which is in use on a short line in Paris, has now been installed on a section of tramway in Dresden, where it has been under test for some months past. The section is about 1,000 feet long. A car has been equipped to run over the section, with a magnetized bar underneath it for lifting up the armature in each contact block and thus making the circuit. A rail return is used. To provide for the lighting of the car at the points where the line changes over from surface to overhead, osmium lamps are used, supplied by a six-cell storage battery. The latter is also employed to excite the magnets of the bar. The trials have been favorable to the system, and it is said that the municipality has authorized the company to extend the Dolter system to all its lines. At present these lines use an accumulator car.

The Edison accumulator may soon find a rival in the new light battery which M. Jeantaud, the well-known electric automobile constructor, has just brought out. Some of the recent tests which were made at the Laboratoire Centrale, of Paris, showed that the capacity of the new element is considerably higher than that of the usual types. The battery is formed of lead positive and negative plates. Both plates are formed by pasting with a lead oxide preparation. The use of the composition (which is kept secret at present) allows of obtaining a voltage which is five per cent higher than the ordinary cell. With an equal mass of electrodes the capacity of the new cell is stated to be from forty to fifty per cent higher than with plates pasted with red lead and litharge. M. Janet, the director of the laboratory, made a series of official tests on the new cell, which was sent in a charged state. It started with a terminal voltage of 2.07 volts and after discharging the voltage was 1.7 volts. It delivered 41.2 watt-hours per kilogramme weight, at the rate of 5.5 watts per kilogramme. The electrolyte is sulphuric acid as usual, but a considerably higher density is used in this case, as it is 1.32 or thirty-five degrees Beaumé at the start and 1.16 or twenty degrees at the end of the discharge. As to the output of energy relative to the weight of the cell, the above test shows that it is considerably higher than the ordinary cell, as we have forty-one watt-hours per kilogramme instead of twenty-five watt-hours which is the average figure. This increase may be due to the great density of the electrolyte, and it remains to be seen whether the cell has a long life. Commenting upon these results, M. Hospitalier recalls the performance of a battery which M. Krieger used in a long-distance run with his automobile. He ran as far as 307 kilometres (190 miles) with a single charge of battery. The cells gave 2.15 volts at the start and the battery furnished thirty-eight watt-hours per kilogramme. It is a question whether in this case the cells were not deteriorated very soon, and nothing is known as to this point. The duration of the cell is a factor which must not be neglected in a practical test.

The Ritchie telautograph (American type) has been recently improved and reconstructed with different modifications by Georges, Isaac and Mambret, of Paris. The improvements are said to consist in the use of automatic electric regulation instead of mechanical devices, and the apparatus can be employed together with the telephone on the government lines. One advantage of this is that it will allow of countersigning orders which are sent by telephone, and this will be of considerable use in commercial transactions. The new system has been tested not long ago from Paris to Rouen, ninety miles distance, with ground return and is said to have operated very well.

The question of preventing accidents in factories and the different kinds of appliances for protecting workmen has been taken up in Paris by a technical commission of the Conservatoire des Arts et Metiers. An important step will be the establishing of a museum or place of exhibition and testing for different apparatus of security or hygiene, and will represent the latest progress along these lines. Drawings and photographs of different apparatus which can not be otherwise secured will be shown. In many cases it is intended to operate the machines by electric motors so as to show their efficiency in actual practice. The conservatoire will take all the needed measures to keep the exhibition up to date and new devices will be constantly added and given the necessary tests, while the old ones will be eliminated as they become replaced by improved devices. It is intended to afford free space and motive power to constructors who wish to have their apparatus tried here. The constructors will still remain in possession of their apparatus, which will be simply loaned to the exhibition for a certain time.

Some recent experiments made by the German physicist Paschen demonstrate the effect of a secondary or induced radio-action upon a photographic plate. He places pieces of platinum foil of different thicknesses upon a dry plate. The β-rays from radium bromide cause the shadow of the platinum foil to be projected on the plate, as is shown after developing. Next, the radium bromide is enclosed in a covering of sheet lead. Here the shadow on the plate is not as well defined and grows less as the lead covering is made thicker. The pieces of platinum foil which had a thickness below ten μ did not produce any shadow and in this case the photographic plate had a blackened spot which was diffused to some extent over the plate. The experiment seems to prove that the platinum foil placed on the photographic plate gave out a secondary radiation itself and it is this radiation which causes the blackening of the plate. The secondary radiation in the foil seems to be caused by the β-rays from the radium which pass through the lead coating. If the β-rays are considered to be the same as the cathode rays, we no doubt have a Rœntgen-ray effect in this case.

A system of electric road locomotive or motor-car which travels over the ordinary road and takes current from an overhead line is now in use in Germany, at Monheim, and a similar system is operated at Grevenbrück in Westphalia. A third line is running at Bielatel, Saxony. The trolley car is also used in France over a stretch of route near Fontainebleau and at other places. The plant at Monheim is one of the most recent and is now running very successfully. This locality is situated on the bank of the Rhine, and the new line connects it with the station of the Cologne-Düsseldorf railroad, which lies three miles distant. The Schiemann system of electric equipment is used here. High-potential current is furnished to the overhead line from a generating station at Solingen. The overhead system has two hard-drawn copper wires suspended from brackets upon poles. The latter also carry the high-tension lines which supply the town of Monheim with current. The type of motor-car is built on the lines of a large omnibus and takes current in any position on the road by means of a flexible cable which hangs from a specially designed trolley running upon the wires. The car is operated by a thirty or forty-horse-power motor. It carries twenty-six passengers. Besides this form of car the system uses a locomotive which is considerably larger and which is designed to draw one or more trailers. It has two forty-horse-power motors and carries freight and passengers. The trailers are usually freight cars of a special form. The above system has been running under very good conditions for some time past.

C. L. DURAND.

Paris, February 25.

THE IONIC THEORY OF THE ARC AND SPARK.[1]

BY PROFESSOR HENRY CREW.

Ordinary gases, of which air is a type, are, in their normal condition, slightly conducting; but they are, at the same time, such perfect non-conductors that it is only with extraordinary precautions that their conductivity can be measured. Many agents are known, however, which will change a gas into a fairly conducting medium. Among these are uranium rays, X-rays, cathode rays, ultra violet light, high temperatures.

In 1896, Thomson and Rutherford showed that the conductivity of a gas, when once produced, could be removed by either of two methods; namely, by filtering through glass wool and by passing the gas through an electric field. The first of these methods shows that the conductivity is due, as Thomson puts it, to "something mixed with the gas." The second method shows that this "something" is charged with electricity; and since the gas, as a whole, shows no electrification, it is inferred that both positive and negative electrifications are present.

This "something mixed with the gas," these invisible bodies carrying sometimes positive, sometimes negative, charges, these bodies which are "held up," so to speak, by the filter of glass wool, are the particles which are commonly called "ions."

Before passing to the ionic explanation of the spark, it will be necessary to consider briefly the two modes of ionization which are involved in the arc and spark, respectively:

1. Ionization by high temperatures.
2. Ionization by cathode rays.

1. Ionization by High Temperatures—It has been known for many years that hot air—not the "hot-air" of the boy on the street, but the white hot air of the laboratory—is a fairly good conductor of electricity. And it is a rather interesting fact that the earliest study of this subject is due to the French engineer, Du Fay, in 1725. Du Fay will be recalled as the man who discovered that there are two kinds of electrification which we now call positive and negative. (It may be mentioned incidentally that the earliest record of the electric spark is due to Dr. Wall[2] in the seventeenth century, who, by rubbing a piece of amber, obtained a discharge which he says "reminded him of thunder and lightning.") In 1873, Guthrie demonstrated, by experiment, that an insulated red-hot iron ball, in air, can not be permanently charged with positive electricity, but that it can be permanently charged with negative electricity. If, however, the ball is heated to a white heat, it can not retain either positive or negative electrification. It would seem, therefore, that an incandescent solid at moderate temperature emits positive ions; at higher temperatures, both positive and negative ions.

As a beautiful illustration of this may be mentioned the Edison effect which is obtained when an insulated metal strip is placed between the two legs of the carbon filament in an ordinary incandescent lamp. Such a metallic plate may be perfectly symmetrical as regards the two sides of the filament, but, when connected with the positive terminal of the lamp in operation, a very considerable current passes through the connecting wire. If, however, the plate be connected with the negative terminal, practically no current passes, which shows that glowing carbon emits principally negative electricity; a phenomenon of capital importance in the theory of the arc. The negative ions impinging upon the metallic plate reduce it to the same negative potential as that possessed by the negative leg of the filament; hence, no flow of current between them is possible. This phenomenon, which varies with many circumstances, has been elaborately studied by the two German physicists, Elster and Geitel.

2. Ionization by Cathode Rays—The following already classical experiment, described by J. J. Thomson only seven years ago, demonstrates a second mode of ionization which is as fundamental for the spark as ionization by incandescence is for the arc.

If D and E are electrodes, connected with a storage battery of one or two hundred volts, it will be found impossible, under ordinary conditions, to get any current across the intervening air.

But if a beam of cathode rays (which Perrin has shown to be composed of negatively charged particles, moving with a speed which is of the same order of magnitude as the speed of light)—I say that when a beam of cathode rays is allowed to pass lengthwise between "D" and "E," the gaseous medium, if the pressure be not too low, becomes at once conducting.

It looks, therefore, as if the gas molecules between D and E had become targets for the projectiles sent out by the cathode C, the result of the encounter being that either the rapidly moving particle is imbedded in the neutral molecule, thus rendering it a negative ion, or that the neutral molecule is broken up by the encounter, into two parts which act as oppositely charged ions.

The two modes of ionization just described have been established by a large mass of experimental evidence which is perhaps more familiar to many of you than to me, and which needs no further mention.

The fundamental proposition in the theory of the electric discharge, is that what we call an electric current is made up of streams of these small charged particles, the direction and speed of whose motion depend upon the intensity and direction of the electric field in which they are moving. The assumption here involved is merely the assumption that ions in an electric field behave exactly as other charged bodies in an electric field; say, the bell clappers in the "electric chimes" devised by Benjamin Franklin.

Evidence accumulated from various sources has led Thomson to the conclusion that negative electricity is not conveyed through gases by the ions of ordinary electrolysis, but by a particle which he calls a "corpuscle," and which has a mass approximately one-thousandth part that of the hydrogen atom. By others this body is called an "electron." On this hypothesis the current density becomes identically

$$i = (n_1 v_1 + n_2 v_2)\, e$$

where v_1 and v_2 are the speeds and n_1 and n_2 the number per cubic centimetre of positive and negative ions respectively.

Another fundamental proposition is that a corpuscle can not effect the ionization of a neutral atom unless it has the proper speed, and the speed which any particle of mass m carrying a charge e will acquire in a field whose intensity is x depends upon the time during which this field is allowed to act upon the particle.

$$m\, v = x\, e\, t$$

But the value of the time t here depends upon the length of the mean free path in the gas, while this in turn is inversely proportional to the pressure.

Having premised this mere skeleton of the electron theory, and having hinted at the evidence upon which it rests, we may, perhaps, devote the remainder of the hour to the consideration of two questions, namely, what are the criteria for a satisfactory theory of the arc and spark, and

[1] Presented before the electrical section, Northwestern University, December 16, 1904. Reprinted from February Journal of the Western Society of Engineers.

[2] Poggendorff. *Geschichte der Physik.*

how nearly does the electron theory satisfy these criteria?

Every theory must be judged in the highest court of appeal—the court of experimental fact; and among the facts which any competent theory must explain are the following:

1. The fact that the spark potential (*i e.*, the maximum potential difference which can be applied for an indefinite time without producing a spark) varies with the distance between the electrodes in such a way that for any given pressure there is one distance for which the spark potential is a minimum. This distance is called the "critical spark length."

TABLE I.

MEASURING OF CARR, SHOWING RELATION BETWEEN SPARK LENGTH AND SPARK POTENTIAL.

Pressure 1.05 MM.: Gas—Air.		Pressure 2.6 MM.: Gas—Hydrogen.	
Spark Length. Millimetres.	Spark Potential in Volts.	Spark Length. Millimetres.	Spark Potential in Volts.
1	1826	1	1781
2	594	2	462
3	397	3	398
5	355	5	285
10	379	10	317

As a special case of this, and also needing explanation, is the classical result of Hittorf; namely, the fact that a spark under very low pressure will refuse to jump a gap of a single millimetre, while it will pass around a shunt circuit of air between three and four metres long.

2. A second fact is the existence of a "critical pressure"; that is, for any given distance between the electrodes, there is one pressure of the gas at which the spark potential is less than at any other pressure.

3. A third fact needing explanation is that the "critical pressure" multiplied by the corresponding spark length is a constant.

TABLE II.

MEASUREMENTS OF CARR, SHOWING RELATION BETWEEN SPARK LENGTH AND CRITICAL PRESSURE.

Hydrogen.		Minimum Potential 280 Volts.	Carbonic Acid.		Minimum Potential 420 Volts.
Spark Length. Millimetres.	Critical Pressure. Millimetres.	Product of Spark Length and Critical Pressure.	Spark Length. Millimetres.	Critical Pressure. Millimetres.	Product of Spark Length and Critical Pressure.
1	10.3	10.3	1	5.02	5.02
2	5.98	11.8	2	2.52	5.04
3	4.02	12.06	3	1 63	4.89
5	2.8	14.0	5	1.07	5.35
10	1.46	14.6	10	0.51	5.10

4. A fourth fact is that it requires considerably more electromotive force to start a spark across a gap than it does to keep up the sparking after it has once started. This "lag of the spark," as it is called, was studied by Faraday, as early as 1838, and has been observed by nearly every one who has used an induction coil. It is best shown, perhaps, by placing in parallel a set of vacuum tubes filled at different pressures.

5. Fifthly, there is the effect on ultra violet light in accelerating the discharge; that is, in diminishing the "lag."

TABLE III.

WARBURG'S OBSERVATION. THE NUMERATORS INDICATE THE NUMBER OF TIMES THE SPARK PASSED DURING TEN SUCCESSIVE APPLICATIONS OF THE POTENTIAL DIFFERENCES.

Potential Difference in Volts.	960	1440	1500	1920	2040	2940	3000	3960	5040	6000	7020	7920	8940
In the dark							0/10	1/10	1/10	2/10	4/10	7/10	8/10
In daylight			1/10		3/10	8/10							
In the arc light through glass		10/10		10/10									
In the arc light	0/10		10/10										

6. A sixth fact is that the spectrum of air disappears from the light of the spark in air when self-induction is introduced into the discharge circuit; an interesting phenomenon discovered by Schuster and Hemsalech only a few years ago, 1899.

7. Seventh, there is the curious dark space, named after Sir William Crookes,

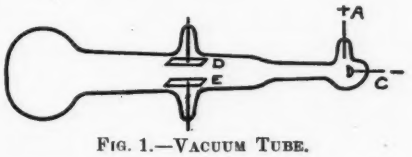


FIG. 1.—VACUUM TUBE.

that surrounds the cathode at low pressures.

8. In the eighth place, we ought to know why it is that an electromotive force of only thirty or forty volts is sufficient to operate an arc, while at least ten times this voltage is necessary to produce a spark in air.

9. Next, there is the strange fact that the anode in the arc is always hotter than the cathode; also the fact that a crater is formed in the positive carbon electrode.

10. Ten, the existence of the so-called counter-electromotive force in the arc.

11. And with this goes the remarkable behavior of the arc in, so to speak, disobeying Ohm's law; that is to say, with any given impressed electromotive force at the terminals of the arc circuit, we find that the electromotive force between the electrodes varies not directly, but inversely as the current.

This phenomenon is most beautifully seen in any form of the oscillograph which gives the electromotive-force curve and the current curve simultaneously; for then, one of these curves appears as the image of the other in a mirror placed parallel to the time axis.

12. The effect of chemical combination in reducing the potential difference required to maintain an arc. In the same category comes the effect of oxygen in preventing hissing.

13. And lastly, any competent theory ought to explain why it is that no Doppler effect is observed when an arc or spark is examined with the spectroscope.

The foregoing are but a portion of the phenomena exhibited by the electric discharge; but they are, I think, sufficiently varied and fundamental in character to form a severe test of any theory.

We now pass, therefore, to the second of the two queries proposed at the outset; namely, to what extent is the electron theory capable of accounting for these phenomena?

These thirteen facts have not been selected because they are all easily explained on the ionic hypothesis; on the other hand, some of them appear to me quite inexplicable; but it sometimes happens that the most important thing to be known about a theory is the points at which it fails.

Let us imagine the region between two electrodes, to be occupied by an ionized gas. If there is no potential difference between the electrodes, the positive and negative ions will encounter each other in the manner described by the kinetic theory of gases and will gradually unite

to form neutral atoms. The conductivity of the gas will thus gradually disappear.

If, however, there exists between the electrodes a field of electric force, it is evident that the positively charged ions will travel toward the cathode, and the negative ions toward the anode. Unless the potential gradient be very large, the ions will be gradually swept out of the field and the current will die down.

But if, by any means, the supply of ions be renewed at a constant rate, the current will keep up; not only so, but the current will increase with the electromotive force until a point is reached where the ions are being swept out of the field at the net rate of their production.

The maximum current then is produced by an electromotive force which clears the field of ions, as rapidly as they are produced. This is what Thomson calls a "saturation current."

If the potential difference between the

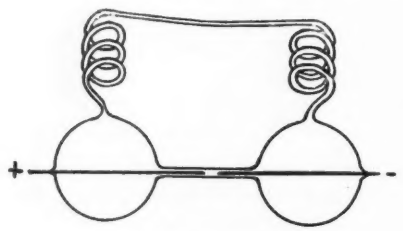


FIG. 2.—HITTORF'S TUBE.

electrodes be increased still further, a point will finally be reached where the ions will acquire such high speeds that they are able of themselves to produce new ions by collision.

The experimental results obtained by Thomson, Townsend and Schweidler are summarized in the figure on the screen. From zero to an electric field of 600 is the region in which all bodies, solid, liquid and gaseous, behave more or less alike; that is, they all obey Ohm's law. From 600 to 1,100 is represented the saturation current. At 1,100 begins the stage where the electric field produces its own ionization. In air, at atmospheric pressure, this potential gradient is about 30,000 volts per centimetre. It is this last region to which belongs the spark. If the facts summarized in the last figure on the screen have been correctly explained in terms of the ionic hypothesis, we are now in a position to explain the first of our thirteen experimental facts; namely, the existence of a "critical spark length."

1. For if the electrodes are very close together, and if all side discharges are prevented, the electric field will be very strong, but the amount of gas between the electrodes, especially at low pressures, will be very small; so small, indeed, that even if it be completely ionized, it will not furnish ions sufficient in number to carry any appreciable current nor will they furnish sufficient heat at the electrodes to enable these to produce ions by incandescence.

On the other hand, if the electrodes be widely separated, the electric field will not be sufficiently strong to produce continuous ionization by the velocity which it impresses upon the ions already there. Between these two extremes, at each of which practically no current is found, we may, therefore, reasonably expect a certain spark length at which the current will pass more easily than at any other. This is where the electrodes are close enough to produce the required electric intensity, and where, at the same time, the total number of ions between the electrodes is sufficient to carry a visible current, that is, a current which is able to produce light effects. This is the critical spark length so beautifully illustrated by Hittorf's experiment. See Fig. 2.

2. Passing now to the variation of spark potential with pressure, it is necessary to recall that the mean free path of a molecule varies inversely as the pressure. It is evident, therefore, that as the pressure diminishes in any spark-gap, the electric field has a longer time during which it may act upon an ion. For the time during which an ion is free to be acted upon, is proportional to its mean free path.

As the pressure diminishes, therefore, the ions more readily acquire the speed necessary to produce ionization by collision; and hence more readily start the spark.

If on the other hand the diminution of pressure be carried too far, the medium between the electrodes may become so impoverished in ions as to be unable to conduct anything but a minute leakage current; quite imcompetent to produce any luminous effects. Somewhere between these two lies the "critical pressure" which requires a minimum spark potential, already illustrated by the curve shown in Fig. 3.

3. Let us now pass to the third of our experimental facts; namely, Paschen's law, that the product of the critical pressure by the critical spark length is an invariant, so long as the potential difference remains constant.

We have seen that for any given spark length, there is a critical pressure, and we know, from the kinetic theory, that the pressure varies inversely as the mean free path. We have seen also, that for any given pressure there is a critical spark length, and that this varies directly as the mean free path. A very small induction coil will produce a spark four or five feet long if the mean free path of the ions is sufficient.

It is not surprising, therefore, that under the conditions stated, namely, constant potential difference, we find the product of these two oppositely varying functions of the mean free path to be a constant.

Let us denote the mean free path by λ, then what we should expect from the electron theory may be more clearly and briefly put, as follows: the critical varies inversely as λ; the critical spark length varies directly as λ. We might, therefore, expect that the product of these two would

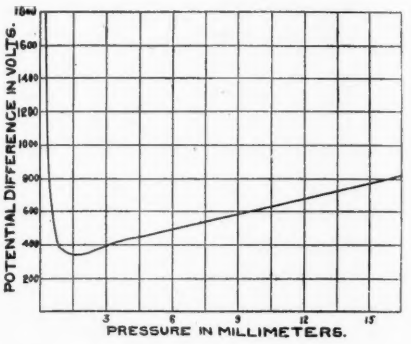


FIG. 3.—CARR'S OBSERVATIONS.

be a function independent of λ; in other words, we might expect the product to be a constant so long as the potential difference is constant. This is precisely the fact discovered by Paschen[1] in his doctor's dissertation in 1889.

The experiments which Earhart has recently performed at the University of Chicago lead to results which at first glance are somewhat anomalous. He finds that when the sparking distance is reduced to something less than six wave lengths of light, the minimum spark potential is no longer 350 volts, but about one-tenth of this. But under the conditions of his experiment, the intensity of the electric field at the spark-gap is about one million volts per centimetre. Thomson has computed that a field of this strength will be able to drag the corpuscles bodily out of the surface of the metal, within which they are supposed to move with great freedom, provided the distance of the corpuscle from the surface of the metal is something greater than the millionth of a millimetre. The electron theory is, I think, quite capable of han-

[1] *Wied. Ann.* 37. (1889.)

dling this apparently exceptional, but well established case.

4. We pass now to the fourth experimental fact; namely, the "lag" of the spark. If the spark discharge is initiated by the electric field impressing upon the few stray ions which are found in the spark gap, a velocity sufficient to ionize their neighbors and if the potential difference between the electrodes is very little larger than that necessary to produce a spark, it would seem eminently natural that a little time should be required for this bombardment to produce ions sufficient to carry a luminous current; *i. e.*, a current producing luminous effects. And this is exactly what has been observed. Warburg[1] found that in some cases as much as three minutes elapsed between the application of the potential difference and the passage of the spark. On the other hand, so far as I am aware, no one has yet shown that, during the period of the lag and preceding the spark, there exists any current at all. Until this point is cleared up, we can hardly admit that the ionic theory of the "lag" has been established.

5. Next comes that surprising fact discovered by Hertz in 1887; that a beam of ultra violet light will bring about a spark between two terminals of an induction coil when the potential difference alone is unable to do it. Since ultra violet light is well known to render a gas conducting, it is, of course, not surprising that it should ionize the air between the electrodes and thus assist in starting the spark. But besides this, ultra violet light enables a negatively electrified body to emit corpuscles. Hence, if the ultra violet light falls on the cathode, we can expect assistance to the discharge in this way also.

If it be asked why light should assist in the discharge of a negatively electrified body rather than of one positively charged, the explanation would seem to lie in the fact that the negative ions set free from metals are the very minute corpuscles which move with much greater rapidity than the positive ions; and having much less mass, are more responsive to the electric forces which, according to the electromagnetic theory, appear in the wave-front of any beam of light.

Under normal conditions, of course, the corpuscles in the surface of the metal are attracted and held by the positive ions near them. The electric intensity in the wave-front acts upon these corpuscles, therefore, very much in the same manner that increase of temperature acts upon the molecules of a liquid to produce evaporation.

This phenomenon, therefore, which was discovered by accident in 1887, is one which might, to-day, be easily predicted by the electron theory.

6. Let us next consider the curious effect produced upon the radiation of the spark by the introduction of self-induction into the discharge circuit. Schuster and Hemsalech photographed the spectrum of the spark discharge upon a photographic film which was moving at the rate of 300 feet per second in a direction at right angles to the discharge. The curvature of the spectral lines so photographed indicates the speed of propagation between the electrodes, just as the angle between the two bow waves of a boat determines the speed of the waves in terms of the speed of the boat. This enabled Schuster and Hemsalech to separate the discharge into two quite distinct parts.

First, there is a series of lines which are apparently perfectly straight, showing that the speed with which their disturbance is propagated from one electrode to the other is very large when compared with 300 feet per second. These lines were found to belong to the spectrum of air.

Secondly, there is a group of lines which are distinctly and measurably curved. These belong to the metal of which the electrodes are composed. They constitute the luminous cloud which accompanies the spark and which is called the "aureole."

We have, therefore, in the ordinary discharge (*i. e.*, in a circuit including some capacity) two principal phenomena; first, a spark in air, a pilot spark, so to speak, which fills the region with gaseous ions; secondly, the electrodes are heated and the metallic ions are driven out into the spark-gap. These carry the oscillatory discharge which follows the pilot spark.

With this structure of the spark in mind, we are in a position to predict the effect of putting self-induction into such a circuit; namely, the period of oscillation will be increased, the metallic vapor will have time to diffuse through the spark-gap and most of the energy will be spent in heating this vapor instead of the air. Consequently the air lines in the spectrum will become relatively insignificant when compared, as to intensity, with lines due to the metal. This is exactly the fact discovered by these two English physicsts, Schuster and Hemsalech in 1899. The regular method now employed in the laboratory for ridding a spectrum of air lines is, therefore, to insert self-induction. See Fig. 4.

7. Passing next to what is perhaps the most striking peculiarity of the ordinary vaccum tube—the dark space of Crookes—which surrounds the cathode, it must be confessed that the explanation offered by the ionic hypothesis is not so satisfactory as might be desired. This want of clearness may, however, be merely my own want of comprehension. The argument is as follows: J. J. Thomson[1] has measured the amount of ionization at various points along the tube, from the cathode down through the negative glow, and he finds that the ionization is a maximum at points where the luminosity of the tube is a maximum; in other words, he finds that the more rapidly moving and the more slowly moving corpuscles are unable to produce as much ionization, in a given length of time, as those corpuscles which move with certain intermediate speeds. The dynamical explanation of this fact is not clear to me.

Just near the cathode there is an enormous drop of potential, the so-called "cathode fall"—this means that the electric intensity is here very great—in passing through this drop the negative ions acquire such a high speed that they pass through a considerable distance without producing much ionization. But these

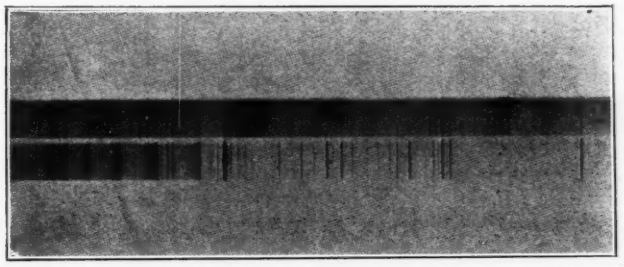


FIG. 4.—CARBON SPARK SPECTRA. (*a*)—WITHOUT INDUCTION. (*b*)—WITH INDUCTION. AIR LINES ARE ELIMINATED FROM *b*.

[1] *Wied. Ann.* 59. (1896.)

[1] *Phil. Mag.* 1. (1901.)

"secondary" ions, which Thomson calls the "descendants" of the primary corpuscles, will have greater power of ionization in passing through any given distance, and it is these, which, by their collisions with the netural gas molecules, produce the negative glow. The stream of negative corpuscles emitted by the cathode is supplied in all probability by the bombardment of the cathode by positive ions which have just acquired large kinetic energy by passing through the "cathode fall." The experimental evidence for this view is furnished by the experiments of Schuster and Wehnelt who placed a solid obstacle in the Crookes dark space and found that that portion of the cathode which was shielded emitted no cathode rays.

The stratified discharge is explained as follows: the region between the anode and the locus of ionization just described will tend to become filled with negative ions; for, since the positive ions originate in the negative glow, the electric field will carry them toward the cathode and leave the region between the anode and the negative glow entirely devoid of positive ions and entirely filled with negative ions. But according to Poisson's equation $\frac{d\,F}{d\,x} = 4\,\pi\,\rho$ if we have given a negative value of ρ as above assumed, then as we recede toward the anode, that is, as we diminish x, we must find F increasing; that is, an increasing field. Hence, the negative corpuscles present in this field may acquire sufficient speed to again produce ionization. When this is the case, we have a second negative glow. We may, in like manner, have this phenomenon repeated. This is the well-known stratified discharge.

8. We are now in a position, perhaps, to consider the eighth query, how can the arc be operated on thirty or forty volts, while for the spark ten times this voltage is necessary?

The first point here involved is the fact that the two discharges are started by totally different methods. In the case of the arc, the ionization is started by high temperature; in the case of the spark, it is started by a powerful electric field. In the arc, the high temperature is acquired by allowing the electrodes to come into loose contact in such a way as to localize considerable Joule heat in the electrodes, thus bringing them each to incandescence, so that each emits both positive and negative ions. The only voltage here called for, then, is a very small one—just enough to make the carbon tips white hot, the resistance being very small.

In the case of the spark, however, the resistance between the electrodes is practically infinite: the ionization must be started by the speed impressed upon the few stray ions already present, and the experimental fact is, that even under the most favorable circumstances, this requires between 300 and 400 volts.

The experiments of Schuster and Hemsalech have shown that after the arc and spark are each started, there is very little difference in their behavior.

The intermittent feature of the spark from an ordinary induction coil is, of course, a non-essential—due entirely to the intermittent character of the impressed electromotive force. The same is true of the alternating-current arc and of the oscillatory discharge from the Leyden jar. The typical arc is that furnished by the direct-current and the typical spark is that produced by a steady electromotive force, say a storage battery of 1,000 or more cells in series—the Glimmstrom of the Germans.

Two other questions now arise: does the spark require 350 volts only for the

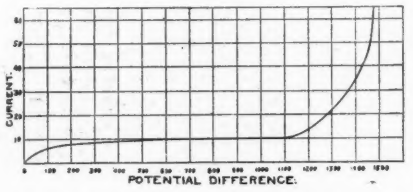


FIG. 5.—SATURATION CURVE.

purpose of starting it? And, since in the case of the arc, much less than thirty volts will heat ordinary carbon tips to incandescence, why the necessity of thirty or forty volts to operate an arc?

The reply to both of these queries is that the discharge is unstable whenever the resistance of the external circuit exceeds

$$\frac{(E - A)^2}{4\,\beta}$$

where A and β are defined by the following empirical equation which is the form Ohm's law takes when applied to the arc:

$$E = R\,i + A + \frac{\beta}{i}$$

This equation of Mrs. Ayrton[1] has been derived by J. J. Thomson from his view of the arc; namely, that a hot cathode is the essential feature, the cathode being bombarded by the positive ions to such an extent that it is kept incandescent. The only purpose of a hot anode is to furnish the positive ions for this bombardment—this is shown by Fleming's experiment in which he obtains a current easily between a cold anode and a hot cathode—the cathode meanwhile being kept hot by a second anode which is hot.

Summed up in plain English, the arc becomes unstable as soon as the current reaches a value too small to keep the electrodes hot; for, if the ionization is furnished by heating the electrodes artificially, a very trifling electromotive force sends a current through the region ordinarily called the arc.

9. The next question concerns the high temperature of the anode. This is a matter which, it seems to me, needs further investigation. It is well known that the anode drop is, in the case of the carbon arc, some four times as great as that of the cathode fall. The high temperature of the anode may, therefore, be due to the enormous kinetic energy acquired by the negative ions in passing through this intense electric field. On the other hand, it seems quite possible that this big drop of potential at the anode is due to the very liberal ionization which accompanies the high temperature of the anode.

For, since $\frac{d\,F}{d\,x} = 4\,\pi\,\rho$ the field strength F will increase (or decrease) very rapidly with x through any region where ions of one sign are abundant, and there will be ions of one sign—namely, negative sign—very close to the anode, where they are driven by the electric field.

This problem is certainly one where a more accurate knowledge of the distribution of ions throughout the arc is needed, and until this knowledge is obtained, the charge of incompetency must here be sustained against the electron theory.

10. An old puzzle in connection with the arc is the existence of a so-called "back electromotive force"—the phenomenon which we have numbered 10. I think the experiments of Hotchkiss[1] at Cornell have proved with very tolerable certainty that the arc has no *bona fide* back electromotive force in the ordinary acceptance of that term—at least if there is such an electromotive force it amounts to less than one volt and its existence is tremendously brief after the current is shut off. In this respect it is certainly very unlike any "back electromotive force" of polarization. The phenomenon left to explain is, then, the well-established anode drop and cathode drop, a phenomenon observed alike in the arc and in the vacuum tube. And these in terms of the electron theory, would be due to a distribution of ions presumably something like that in the figure on the blackboard, namely, a layer of positive ions near the

[1] "The Electric Arc," Mrs. Ayrton, p. 205.

[1] *Bull. Amer. Phys. Soc.* Vol. ii, No. 2, p. xix. (1901.)

cathode and a layer of negative ions near the anode.

Here again Poisson's equation shows that where either kind of ionization exists there is a change in the electric intensity, and hence a drop in potential. The drop in potential throughout the gaseous portion of the arc is small and constant[1]—which would be perfectly explained if we assume that in this region there are as many positive as negative ions in each element of volume. Here again the demand is for more exact knowledge of the actual distribution of ionization. Duddell thinks he has obtained evidence that this potential difference is really a thermoelectric effect; but it is very difficult to imagine a difference of temperature able to produce a potential difference of thirty volts, and yet a difference of temperature which can disappear in one one-thousandth of a second. In addition to this, as Mr. C. D. Childs has pointed out to me in a letter, the potential difference in the arc still remains, even when the anode is colder than the cathode; also we know of no other thermoelectric forces which are even of the same order of magnitude as thirty volts.

11. If we attempt the explanation of the fact that the potential difference between the electrodes of the arc diminishes as the current increases, we shall find that the minute anatomy of the arc, so to speak, is not sufficiently well understood to predict the equation with which Mrs. Ayrton has described the arc so perfectly.

But it is possible, by assuming two streams of ions in the arc, traveling with different velocities, and by assuming that the kinetic energy with which they bombard the anode and cathode is acquired by their falling through the anode and cathode potential difference, respectively—I say, it is possible by making these assumptions and equating the heat thus delivered at the poles to the heat which is radiated from the poles and which is spent in ionization, to obtain an equation which is practically identical in form with that of Mrs. Ayrton.

12. This same idea gives us at once the key to the next phenomenon on our list, *viz.*, the effect of chemical combination in reducing the potential difference between the electrodes, the current being kept constant. Since all the electromotive force required is just what is sufficient to maintain the proper incandescence, it is evident that if a part of the heat is furnished by chemical combination, less power will be required from the electrical source and hence with any given current less electromotive force will be required.

13. Passing now to the last phenomenon on our list, which lies in a somewhat different field, it has been thought by many observers that, if the light of the arc and spark is due to two streams of ions moving rapidly in opposite directions, from one electrode to the other, then one ought, in looking along the direction of the discharge, to see any spectrum line displaced from the position which it occupies when viewed at right angles to the discharge; in short, one would expect to find the Doppler effect here precisely as it is found in the case of the sun where one limb is constantly moving toward us and the other away from us. The yellow sodium line, for instance, has a distinctly different position in the spectrum of either limb of the sun from that which it has in the spectrum of the centre of the solar disc. But not the slightest effect of this kind has ever been detected in either the arc or spark. Hence it would appear that ions do not radiate while they are moving with uniform speed through an electric field. This experimental fact is in perfect accord with the electromagnetic theory of radiation as worked out by Larmor who has shown that the radiation of a moving charged particle depends upon the square of its acceleration and becomes zero, not when the velocity becomes zero, but when the velocity becomes constant. In other words, ions emit electromagnetic waves and become radiant practically only during collision.

We have now, I think, considered phenomena which are sufficiently numerous and sufficiently varied to prove that without some reasonable hypothesis, an intelligent study of the arc and spark is a practical impossibility.

The electron theory is very young—one can count its years upon the fingers of a single hand. The theory, as it stands to-day, is merely a first step toward a more complete description, based strictly upon experimental evidence. At the same time, so far as I am aware, the ionic hypothesis is the only one which has shown any degree of competency whatever. This theory has also the additional advantage of explaining at the same time, and without essential modification, the multitudinous and highly important phenomena of radioactivity, magneto-optics, and perhaps also the periodic law of Mendeleef.

On the whole it would seem, therefore, that the electron theory forms the best working hypothesis we yet have for the prosecution of further studies in this field. As Huxley has pointed out, most great truths are first regarded as heresies, and finally as superstitions. The electron theory is yet in the first stage, awaiting a second Newton who will do for the atomic system what the first Newton did for the solar system.

[1] J. J. Thomson, *Cond. Elec. Gases*, p. 422 and Fig. 121.

Wireless Telegraphy in the Home.

To the Editor of the Electrical Review:

I have read with much interest Mr. W. J. Hammer's letter in the Electrical Review of February 25, 1905, relative to his application of wireless telegraphy to domestic purposes. Every one must admit that wireless telegraphy is applicable to the starting of music boxes, to fire-alarm telegraphy, to the ringing of door-bells and the other bells that Mr. Hammer enumerates. I might say that when wireless telegraphy was first introduced, about five or six years ago, and the world was agog over the new art, the writer, to entertain and amuse a party of his friends, used it one evening at his home for the purpose of ringing the bell in a progressive game of cards. To this end a push-button connecting with the transmitter was arranged at the "head" table in one room, while the coherer with a short antenna was placed in an adjacent room. The arrangement worked quite successfully and the guests were delighted with the novelty of the affair. In this case also the apparatus used was made by Mr. W. J. Clarke. To advocate the use of wireless telegraphy to displace permanently an ordinary electric door-bell, however, is quite a different matter. The electric door-bell will operate nicely with two dry cells for twelve months or more, and the entire outfit may cost one or two dollars. Mr. Hammer uses twelve cells for the operation of his wireless call-bell. How long lived these cells would be is problematical, and I should not like to mention in comparison the cost and maintenance of the wireless outfit. Personally, while I am a great admirer of wireless telegraphy and a firm believer in its present and ultimate possibilities, I shall in the existing state of the art stick to the electric bell for the front door and for calling the kitchen-maid. I should not care to risk being called upon twice, thrice or oftener during the meal to adjust the ordinary filings coherer. Nor do I think the needs of the case are sufficient to warrant the employment of syntonic devices (and an expert to watch the devices) to avoid the clashing of the door bell and kitchen bell signals when either should be operated. I get over the difficulty of groping for the floor-push in the dining room by using a neat circuit-closer attached to the table with a flexible wire of sufficient length to allow for moving the table when desired. But as a novelty and a diversion, I would agree with my friend, Mr. Hammer, that this use of wireless telegraphy is very pretty.

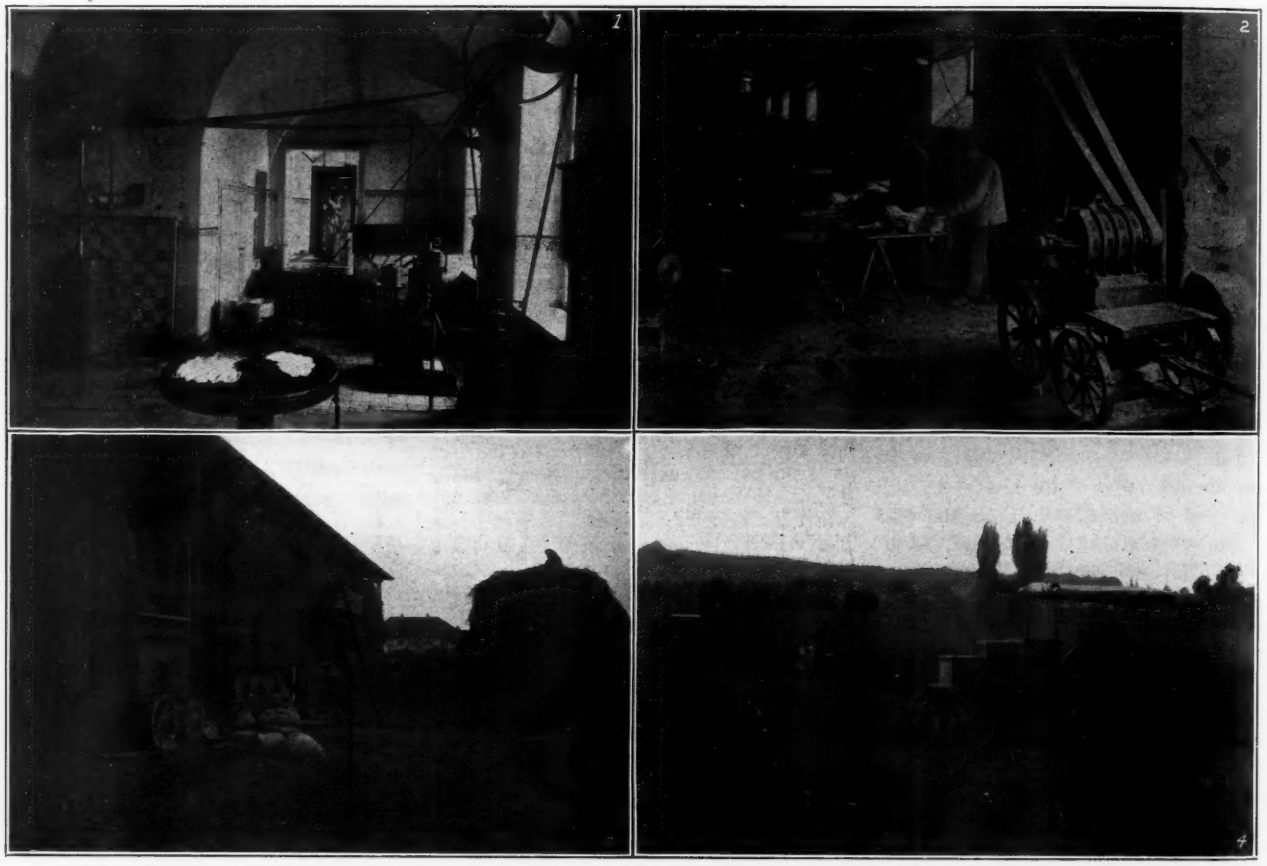
Wm. Maver, Jr.

New York, March 2.

ELECTRICITY IN AGRICULTURE.

BY C. L. DURAND.

The uses of electricity for agricultural purposes are continually on the increase in Europe, especially in Germany, where it is employed on a number of large farms. Many of the leading proprietors have been brought to see the advantages which they could obtain by the use of electric motors placed throughout the premises for carrying on the different operations connected with farm work.



ELECTRICITY IN AGRICULTURE. FIG. 1.—WORKING DAIRY APPARATUS. FIG. 2.—WORKING SHEEP SHEARING MACHINERY. FIG. 3.—HARVESTING MACHINERY. FIG. 4.—TILLING AND SOWING MACHINERY.

The installation of a small electric plant does not involve a great outlay of capital, at least in cases where the production is considerable, and there is no doubt that the modern methods which are coming into use will be quickly taken up once their advantages have been demonstrated. The well-known Berlin firm, the Siemens-Schuckert Company is among the leading spirits in promoting the use of current in agricultural work and has already put in a number of plants on some of the large farms in Germany.

Some of the different uses to which motors can be put are shown in the present engravings. One of these represents a dairy plant which is laid out on modern principles. In the rear is a mechanical churn of large capacity which is driven by belt from a small direct-current motor. A second motor is used to operate the butter-working machine, which is seen in the foreground. A model sheep-shearing plant is shown in another view. In this case a portable motor mounted on a four-wheeled truck is employed. The use of the portable motor is especially advantageous on a farm, as many different operations can be carried out by running the motor from one place to another, according to the needs of the work. A motor having about three-horse-power capacity is generally sufficient for most of the light work such as is shown here. In some cases the electric machines were installed on the premises originally for lighting, and afterward it was found that motors could be used to advantage; this keeps the plant running during the day and thus increases its efficiency.

One of the first applications of electric motors has been to drive threshing machines, and one of the engravings shows a plant of this kind. From five to twenty-horse-power motors are required, according to the type of thresher used.

Electric motors are found to cost much less to operate than the steam locomotives which are often used to run the threshers. Thus a ten-horse-power steam locomotive is estimated to cost from fifteen to twenty pfennigs ($0.038 to $0.050) per horse-power-hour, while an electric motor under the same conditions can be operated for eight to fifteen pfennigs ($0.020 to $0.038) per horse-power-hour. The present case illustrates the use of the new portable motor outfit which the Siemens-Schuckert firm is placing on the market. It drives the thresher by belt, and no change need be made in the case of threshing machines which were already adapted for use with steam engines. The portable motor can naturally be used for other operations when not employed here.

A question which has been much discussed of late is that of electric plowing. There is no doubt that motors will come into use extensively for this purpose. In this case electricity comes into competition with steam and under favorable local conditions the electric method has proved

to be cheaper to operate, besides being greatly superior as to ease of handling. We illustrate one of the most recent methods of electric plowing which is used on some of the large German farms. It is known as the double-machine system. Two specially constructed portable machines known as plow-wagons are employed. The wagons carry a motor-driven cable drum and the steel cable is stretched across the field, having the plow attached to it in the middle. The plow is thus drawn back and forth between the two wagons and after one furrow is cut the wagons are advanced by the proper distance for cutting the succeeding furrow. Current is brought into the wagon by a separate drum which rolls upon wheels in the rear of the wagon and the cable is fed out along the ground as the wagon advances. The plow is given a speed of four or five feet per second, using motors varying from forty to sixty horse-power. The motor is designed so that it will give a 4,000-pound traction on the plow cable at the above speeds.

The First Annual Convention of the Bell Telephone Company Managers.

On February 21, 22, 23 and 24 a large number of telephone officials and managers held a conference at the Claypool Hotel in Indianapolis, Ind. The subject principally dealt with was the betterment of the telephone service.

A paper entitled "The Selection and Training of Operators" was read and discussed at the first session. This paper was presented by H. D. McBride, of the New England Telephone and Telegraph Company. A paper on the subject of "Local Service Tests and the Merit System of Grading Operators" was presented by A. S. Rogers, of Omaha. In the afternoon F. P. Valentine, of Boston, presented a paper entitled "Local Operating Methods and the Handling of Irregular Calls."

Other papers were presented at the sessions subsequent to the first day, as follows: E. F. Sherwood, "The Handling of Suburban Toll Traffic"; M. C. Rority, "Toll Service Tests and the Checking of Toll Revenues."

H. H. Kennedy presented a paper entitled "The Centre Checking System," and A. P. Allen read a paper entitled "Tariff and Routing Systems." A paper entitled "The Handling of Long-Haul Toll Traffic" was presented by J. L. R. Van Meter.

The officials of the Central Union Telephone Company, of Indianapolis, tendered a banquet at the Columbia Club, on the evening of February 23. The toastmaster was J. L. Richardson, president of the Central Union Telephone Company. Responses were made to toasts by F. P. Fish, president of the American Telephone and Telegraph Company; Angus S. Hibbard, vice-president and general manager of the Chicago Telephone Company; C. E. Yost, president of the Nebraska Telephone Company; Alonzo Burt, president of the Wisconsin Telephone Company; E. B. Field, president of the Colorado Telephone Company; H. B. Thayer, vice-president of the Western Electric Company; F. M. Hill, general manager of the Central Union Telephone Company; A. D. Wheeler, president of the Chicago Telephone Company, and the mayor of the city, J. W. Holtzman.

Among other well-known telephone managers there were present U. N. Bethell, vice-president and general manager of the New York Telephone Company; Henry M. Watson, president of the Bell Telephone Company, of Buffalo; E. J. Hall, vice-president of the American Telephone and Telegraph Company; T. Spencer, general manager of the Bell Telephone Company, Philadelphia; George F. Durant, general manager of the Bell Telephone Company, of Missouri; B. L. Kilgour, general manager of the Cincinnati & Suburban Bell Telephone Company; F. A. Houston, general manager of the New England Telephone and Telegraph Company; J. C. Reilly, general manager of the New York & New Jersey Telephone Company, and F. H. Bethell, general manager of the Chesapeake & Potomac Telephone Company.

The New Cunard Liner Caronia.

The new twin-screw steamship Caronia, the latest addition to the Cunard Line fleet, was docked for the first time in New York harbor on Sunday evening, March 5. The new steamship is 675 feet long, with a breadth of seventy-two feet six inches. Her smokestacks reach to a height of 150 feet above the keel. She is designed to have a speed of about twenty miles an hour, and is equipped with quadruple expansion engines capable of developing 20,000 indicated horsepower. These engines are of the Yarrow-Schlik-Tweedy system, so steadied by eccentrics as to reduce vibration to a minimum. The various quarters of the ship are fitted with the most modern contrivances. Electricity is made use of wherever possible, and adds very much to the comfort of quarters. The lighting is done entirely by means of electrical apparatus. Four seventy-five-kilowatt dynamos are required to supply current for power. In the illumination system over 3,000 individual lamps are used, and in addition to these there are powerful searchlights. Of course, the ash-lifts, freight winches and boat winches are operated electrically. In addition, there are electric roasters and other electrical novelties.

On Wednesday, March 8, a reception was given by the Cunard Steamship Company, when a large number of visitors made a thorough inspection of the ship.

Important Marconi Invention.

At a lecture before the Royal Institution, London, last week, Mr. William Marconi, the wireless telegraph inventor, announced an invention of great importance to the efficiency of his system. Mr. Marconi said: "I have been able very recently to construct a magnetic detector which will work a relay, enabling messages to be recorded on a tape by the ordinary Wheatstone recorder. The new receiver is far simpler than any yet devised for wireless telegraphy. It requires less attention, and is absolutely reliable. The principal advantage is, however, that the receiving speed is increased from 24 to 100 words a minute."

Meeting of Electrical Contractors and Electrical Supply Dealers.

During several days of last week the electrical contractors and electrical supply dealers were in conference at the Hotel Imperial in this city. The attendance was quite large and representative, and the business transacted related to standardizing of product and prices and a general conference for mutual benefit. A number of leading manufacturers were in attendance, and various committees representing all interests were formed and held meetings. Adjournment occurred Friday afternoon.

Strike on the Interborough Rapid Transit Company's System in New York City.

At 3 A. M. Tuesday, March 7, the employés belonging to various unions, embracing the greater part of the operating departments of the Interborough Rapid Transit Company in New York city, declared a strike on both the subway and elevated lines. The strike was declared jointly by the New York city organization of the Amalgamated Association of Street and Electric Railway Employés, the Brotherhood of Locomotive Engineers, and the Brotherhood of Locomotive Firemen. In anticipation of this trouble, the Interborough company managers had secured the services of a large corps of men, and every effort was made to keep up a schedule during the day.

BOOK REVIEWS.

"The Mechanical Engineer's Pocketbook." William Kent. New York. John Wiley & Sons. Flexible leather. 1,129 pages. 4½ by 6¾ inches. 192 cuts. Supplied by the ELECTRICAL REVIEW at $5.

This is the seventh edition and fortieth thousand of this well-known pocketbook. Four pages have been added on coal-handling machinery, and the section on electrical engineering has been further revised. A complete new index has been written, with about twice as many titles as were contained in the old index.

"Electric Lighting for the Inexperienced." Hubert Walter. London. Edward Arnold. Cloth. 88 pages. 4½ by 7 inches. Supplied by the ELECTRICAL REVIEW at $1.

This small handbook explains, in simple language, things about the electric light that every one who uses it should know. It describes the wiring of houses, the method of running the wire, accessories, lamps and fittings. A study is made of the proper method of lighting a house, the various rooms being treated separately. Some hints are given as to specifications and contracts, and advice for action during emergencies.

"Laboratory and Factory Tests in Electrical Engineering." George F. Sever and Fitzhugh Townsend. New York. D. Van Nostrand Company. Cloth. 236 pages. 6½ by 9½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.50.

This book represents the laboratory work required in the electrical engineering course at Columbia University, where it is used as a text-book. It describes the various tests carried out, giving brief discussions of the theory, when necessary. Illustrated and special and commercial tests are given. The first section is taken up with the direct-current work, and part two with the alternating-current experiments.

"Producer Gas for Power Purposes." W. A. Tookey. London. Percival Marshall & Company. Boards. 137 pages. 4½ by 6 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at 50 cents.

This little book is issued with a view to explaining the advantages of the operation and the application of gas producers to such as may desire to obtain reliable information on this subject in non-technical language. The different kinds of gas are described, and their properties explained briefly before taking up the subject proper. This is treated at some length. The cost of producing the gas is then studied, and a comparison made between the efficiencies of different forms of prime movers. Part two of the book deals with gas produced from bituminous coal. The different types of producers are described and illustrated. Part three contains some useful hints for attendants on producer plants. An appendix contains a description of some of the principle gas producers now on the market.

"La Bobine d'Induction." H. Armagnat. Paris. Gauthier-Villars, Imprimeur-Libraire. Flexible cloth. 224 pages. 5½ by 8½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.25.

This is a satisfactory study of the induction coil. The device itself is explained simply at first, and then an historical review is given. The theory of the induction coil is next studied, and the effect of different kinds of mechanical and electrolytic rectifiers is explained. The character of the secondary current is shown, and curves are given of disruptive voltages. The efficiency and power of coils are given, methods of construction and types of interrupters are explained, and the application of induction coils to wireless telegraphy, radiography and the ignition of internal-combustion engines are described.

"A Treatise on the Theory of Alternating Currents." Alexander Russell. Cambridge. University Press. Cloth. 408 pages. 6 by 9 inches. Numerous diagrams. Supplied by the ELECTRICAL REVIEW at $3.75.

In this volume the author has brought together the mathematical theorems which the electrician uses in his every-day work. In each case the analytical deduction is given, and frequently the application to existing apparatus is shown. The early chapters of the book deal mainly with inductance and capacity. Some practical formulæ are deduced, which it is thought will be useful to the engineer. Chapter twelve discusses graphically some problems in two-phase theory, and illustrates the useful application of solid geometry. In chapter thirteen the theory of alternating-current instruments is given, and approximate solutions shown. Chapter fourteen deals with the rotating magnetic fields, and chapter fifteen with fields surrounding parallel wires carrying polyphase currents. Chapter sixteen is a brief sketch of the method of duality, or of reciprocating a theorem.

"Diseases of Electrical Machinery." Ernst Schulz, with a preface by Sylvanus P. Thompson. New York. Spon & Chamberlain. Cloth. 84 pages. 5 by 7½ inches. 42 diagrams. Supplied by the ELECTRICAL REVIEW at $1.

It is rather strange that more books have not been published, dealing with electrical troubles. It is true that there have been several such books, some of them excellent in themselves, but these are all somewhat old to-day and deal principally with direct-current dynamos and motors. It would seem as though the man who has most to do with the care of electrical machinery has either little time or no inclination to give to the public in printed form the results of his experience. There are books in plenty dealing with the theory of electrical machinery and its construction, but there is a need for a complete treatise on the diseases of electrical machinery. This need will be met, in part, by the present work, which has been written by a German engineer, who spent twelve years as a constructor, and who has had the care of thousands of electrical machines. In the preface of the book Dr. Sylvanus P. Thompson points out some of the interesting features of electrical troubles, speaking particularly of dynamo machines. "Diseases," he says, "may be either congenital—I had almost said hereditary—or acquired. Some diseases affect particular races; others are special to particular climates. Some are incident to youth; others are a prerogative of old age. Some are sporadic, some epidemic, some transient, some chronic, some curable, some incurable." Constitutional diseases may arise from defective design or imperfect construction. Acquired diseases may come from overwork or neglect. To be able to get to the root of the trouble requires not only a familiarity with machinery, but experience with trouble. A wide experience is invaluable. Fortunately, the modern dynamo has developed into a strong, healthy creature. In the early seventies he was a weakling, subject to many infantile sicknesses, and apt at any moment to get into mischief, if not carefully nursed. "His limbs were racked by want of proper balance, and occasionally a sudden high fever caused him to shuffle off a mortal coil or two." In those days not only were the machines themselves far from perfect, but the treatment which they received was sufficient to make any dynamo spark angrily in protest. Mr. Shulz, taking up continuous-current machines, deals first of all with the armature troubles. He explains the usual difficulties, and points out the cause. He tells how to remedy trouble, and how to fit the brushes properly, pointing out the value of carborundum in grinding down commutators. Boosters receive special attention, as they operate under particularly severe conditions. The commutator, the proper method of construction, its care, and the care of carbon and metal brushes are treated satisfactorily. After explaining the different types of armature windings, the faults which may occur are described, and methods of detecting them and proper remedies pointed out. This chapter also describes the proper method

of starting motors, and describes their peculiar troubles. Chapter ii deals with single and polyphase generators. The most important faults here are short-circuits between the windings, as the slip rings rarely give trouble. Breaks, however, may occur, and the windings may be improperly connected. The different methods of winding are explained, and diagrams showing correct and incorrect methods of connection are given. The exciter here comes in for some attention. Chapter iii deals with single and polyphase induction motors, and chapter iv with single and polyphase transformers. A brief chapter on efficiency is added, which describes the usual meaning of this term, and shows how it is obtained. So far as it goes, this is an excellent work. It is clearly written, although the translator has not entirely got away from the German syntax. The reviewer thinks, however, the author could have made the book twice as good if he had made it twice as large, for there are many things which can not be explained in a work so brief, but which should be explained if the operator is to see clearly the causes for his troubles, and thus learn to avoid them. The book, as it stands, however, is a very welcome addition to electrical literature, and should be a great benefit to every operator. It will be no less helpful to the student.

"Producer Gas." A. Humboldt Sexton. Manchester. Scientific Publishing Company. Cloth. 220 pages. 5½ by 8½ inches. 32 figures. Supplied by the ELECTRICAL REVIEW at $3.25.

The author of this timely little work has placed at the disposal of the producer manufacturers much information of value in the way of elucidation of principles and classification of patents, but he has unfortunately passed over with a page of comment the most important subject to the engineer, *viz.*, the practical utility of producer gas in power plants. This is a most conspicuous omission in a work possessing so comprehensive a title. Considerable space is devoted to the metallurgical application of producer gas and it would seem that the author had held this most prominently in mind. It is especially unfortunate that, although dealing with British practice which has advanced, perhaps, further than in any other country, the only reference to actual operating economy of a producer plant to be found between covers should have been a few figures from rather antiquated tests based upon indicated horse-power. It is to be hoped that this important phase of the subject will be embraced in a succeeding volume. As a reference, the book is extremely useful, two preliminary chapters setting forth the elementary principles of chemistry necessary to a proper understanding of the subject, a third devoted to the properties of various gases, and an appendix containing useful saturated vapor tables, while the two remaining chapters and appendix present numerous modifications of the simple producer. An unfortunate choice of an expression for calorific value results in a hopeless admixture of English and metric systems. The necessity for the "centigrade unit" is difficult to see and the majority of American readers will be obliged to make the conversion into British thermal units for themselves. The merits and demerits of the "higher" *versus* the "lower" calorific values of gases (or, in the American parlance, "total" *versus* "effective") should have been brought out more prominently in connection with gas-engine performance. It is a subject that has provoked much discussion in this country, and a statement of British opinion or practice would have been opportune. In defining the commercial efficiency of a gas producer, due credit should be given for the heat reclaimed—either sensible or latent, from whatever source; also the grate efficiency should be included. On the other hand, extra heat required for raising steam above that reclaimed should be charged against the producer. If, in the case of the Dellwick-Fleischer water-gas method, this item amounts, as is stated, to fifteen to twenty per cent of the total fuel used, the ultimate thermal superiority of this process over the ordinary water-gas process is thus brought somewhat into question. The author's enthusiastic support of the system is therefore somewhat inexplicable, especially in the absence of more conclusive data from disinterested sources. On the important point of thermal efficiency of producers, the information is largely of a discursive character and unfortunately little data is presented. This general paucity of data of the practical kind throughout the book detracts somewhat from its authoritativeness as an engineering rather than a scientific work. In the classification of different forms and modifications of producers the author has done excellent work. The novel form developed by Mr. Thwaite—the cupola type—brings to attention a type but little known in this country. Those engaged in the development of the producer will find the descriptive appendix on various patented devices a convenient source of reference. A conspicuous omission is that of direct reference to or opinion concerning the peculiarities of suction producers. The suction plant is, to be sure, out of the question for large powers, but for small sizes it is bound to become popular, and a brief statement concerning its manipulation would have been timely. A discussion of the conditions which a good producer must fulfil brings the author out in an extensive discussion of tar destruction in which he recognizes the partial ineffectiveness of the reentrant principle such as embodied in the Wilson producer. This position is logical and accords with other authoritative opinion, yet it is difficult to reconcile with statements made in descriptions of the Wilson and Thwaite cupola producers that the combustion or gasification is "complete." In the Duff-Whitfield type, gasification is stated to be complete and the gas tar free. It is known that the formation of tar occurs under a definite relation of temperature and time. Under slightly changed conditions, the tar may be broken up into permanent gases and under excessive temperature these permanent gases are themselves disintegrated and flocculent carbon in the form of lampblack deposited. The sensitiveness of the tar destructor device to the unavoidable changes in operating conditions might profitably have engaged the author's attention. Superheating of the air blast is stated to have been attempted in order to augment the efficiency by partial recovery of waste heat, but no data or opinions are expressed as to its success or failure. The important subject of gas scrubbing and cleaning appliances receives entirely inadequate consideration in one paragraph. Centrifugal scrubbers are a distinctly modern development and should have at least received mention. In discussing the ideal producer, the author says: "first, cost should be small. This is, however, of much less importance than the other considerations." This statement is apt to be misleading; gas power in order to compete generally with steam power must suffer the greatest possible reduction in capital costs or fixed charges. The cost of a complete producer plant should be much less than that of a boiler plant, and a sacrifice of refinement might often result in actual operating economy in the end. In place of the complicated, costly and bulky by-product recovery plant is demanded a simple and easily adaptable producer. It is hoped that in thus dwelling upon the opportunities for elaboration or possible improvement, the real value of this book will not be overlooked. It is a valuable addition to a not overcrowded field of technical literature, and being practically the first work, will find ready appreciation in America. It is to be hoped that the near future will bring forth a revised edition dealing with the use of producer gas in central power stations, of which a number have been operating for some time in English territory.

Reviews of Current Engineering and Scientific Literature.

The Berlin Private Telegraph Exchange.

An interesting application of the Berlin printing telegraph system is here given by M. J. A. Montpellier. A central exchange has been established in Berlin, and the transmitting and receiving apparatus have been placed with a large number of subscribers. As they are operated by means of a keyboard similar to that of a typewriter, no special training is necessary. When one subscriber wishes to communicate with another, either to transmit a letter or an order, the exchange is called up and the two stations are connected together. In this way a permanent record is made of the message, both at the sending and at the receiving station. Another use of this system is being made, namely, that of transmitting news items of importance and market reports. The system is used, as well, for transmitting telegrams received in the ordinary way to the subscribers, or retransmitting telegrams which the subscribers wish to send. The rates for this service are as follows: a yearly rental of about $2.50 is charged for each instrument connected to a circuit. The subscriber also pays part of the cost of installing the system. This varies from $7.50 for a single circuit erected on wooden poles to $18.75 for a metallic circuit on iron poles. For each message a charge of about one cent for eight words is made. For retransmitting telegrams the charge is one and one-quarter cents, whatever the number of words. A description of the arrangement at the central exchange is given, the circuits being arranged somewhat as in a telephone exchange, though, of course, the wiring is different. The system is thought to be useful in other applications, such as the communication of orders between different parts of a large factory. The fact that a permanent record of each message is made gives it, for this work, an advantage over the telephone. It is not thought that the writing telegraph will take the place of the telephone, but it will supplement it.—*Translated and abstracted from L'Électricien (Paris), February* 18.

A Contribution to the Theory of the Jungner-Edison Accumulator.

An experimental investigation has been made by M. U. Schoop, to test the recent theory proposed by Roeber of the action of the alkaline accumulator. Roeber holds that there is a change of concentration at the two electrodes, although, as a whole, there may be no change in density. The method used is that of weighing the electrodes after a charge and a discharge. For this purpose the electrode is attached to one arm of a chemical balance, and the changes noted. The following conclusions are reached from this study: this method of experiment enables one to follow the change in weight of the electrode and of the electrolyte at the same time, and also permits a study of the change of the volume of the active matter and the phenomena of diffusion during passage of current. It was found that the changes in volume are greater for the active nickel than for the active iron. The conclusions are in agreement with Roeber's theory. At the two electrodes, differences in concentration are at first during the passage of current, while the concentration of the free electrolyte between the plates remains constant. During discharge the solution is concentrated in the nickel electrode, and is diluted in the iron or cadmium electrode. During charge the phenomenon is reversed. The polarization of concentration takes place principally at the iron electrode. It is probable that temperature influences notably the capacity of the two electrodes. The alkaline accumulator seems to have a temperature coefficient higher than that of the lead accumulator, and this coefficient is positive. The electromotive force increases with the temperature, and the temperature coefficient is independent of the concentration.—*Translated and abstracted from L'Éclairage Électrique (Paris), February* 11.

Foucault Currents in the Armatures of Continuous-Current Machines.

Foucault currents in dynamo armatures are generally treated very summarily. They are dismissed with the brief explanation that they are very small, and therefore unimportant so far as the dissipation of energy is concerned, and that they vary directly as the square of the frequency of induction. This, says M. R. V. Picou, is all wrong, and he backs up his assertion with an analytical examination of the matter. He deduces first a general equation for the Foucault loss in a sheet of iron disposed along the direction of magnetization. This equation consists of several terms, and the influence of these is obtained by making certain assumptions. From a study of the equation it is evident that practically the entire eddy current loss is concentrated in a superficial layer of very little depth. By applying his formulæ to a particular machine, the results of his investigations are shown. This machine is rated at 120 kilowatts, runs at 360 turns per minute, and has 180 slots. Considering first the body of the armature, he shows that the eddy current loss due to the alternations of magnetization is only eighty-six watts—practically negligible. Considering, however, the teeth of this armature, the effect of commutation must be recognized, and it is found that the Foucault loss on the surface of the teeth is 610 watts. The loss at the bottom of the slots is 160 watts, making a total Foucault loss of nearly 900 watts. The loss due to hysteresis in the same armature is about 1,000 watts, so that it appears that the eddy current losses are not negligible, but in a toothed armature are of the order of the hysteresis loss. Turning next to the Foucault loss produced in the face of the poles by the teeth of the armature, it is found that this amounts to twenty-five watts. The following is a summary of this investigation: the eddy current losses in toothed armatures are not negligible, and are of the same order as the hysteresis loss. The greater part of this loss takes place about the slots of the armature during commutation. The equations deduced for the loss show that it does not vary directly as the square of the frequency, and that, therefore, the usual method of separating it from the hysteresis loss is inaccurate.—*Translated and abstracted from the Bulletin de la Société Internationale des Électriciens (Paris), January.*

Armature Coils and Ozone.

In this communication Mr. J. Büchi comments upon a recent article by Mr. J. S. Highfield, who described some difficulty which he had had recently with high-tension alternators, and who attributed this to the formation of ozone and the production of nitric acid. Mr. Büchi does not agree with Mr. Highfield, and he thinks that an entirely satisfactory winding for a high-tension machine may be constructed, even if air be admitted to the windings. He believes that if this danger which Mr. Highfield fears existed, the trouble would have been experienced

at the many plants where high-tension alternators are used. In his experience, the trouble is brought about by a tendency of the designer to economize in the insulation of the separate conductors, because he felt that he could depend upon the excellent insulation of the closed micanite tube. Inspection of a defective coil of such a machine generally shows that the insulation between two conductors has become charred, indicating that a discharge has taken place between adjacent conductors. These defects can be entirely avoided by using ample insulation on the individual conductors, and by a suitable type of winding. Care should be taken not to use too much wire per coil—that is to say, to use a large number of coils, and to arrange the conductors so that the difference in potential between neighboring conductors is kept as small as possible. It is of the utmost importance that the very best quality of materials should be used in the varnishes and insulating compounds. He has found that oxidation of copper has taken place, owing to the use of an inferior quality of shellac which was not free from acid. The necessity for extra insulation on the three end coils is urged, for these are subjected to severe strains when the machine is suddenly switched on the line.—*Abstracted from the Electrician (London), February* 17.

Statistics of Electric Power Plants in Germany.

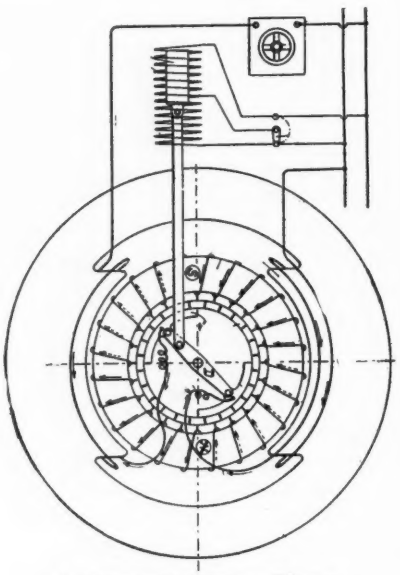
Some very complete statistics are here given of the electrical power plants in Germany. The plants are listed in alphabetical order, and the size of the city, the system used, the method of driving the normal load on the station, the number of arc and incandescent lamps and motors are given, where these have been obtainable. There are in this list 1,028 stations, with a total output of the generators of 434,882 kilowatts. There are, in addition, storage batteries representing an output of 96,065, making a total of 530,947 kilowatts. There are, besides these stations, eighty others, which did not furnish detailed information, and which hence could not be included in the list given. Thus, taken altogether, there are over 1,100 central electric stations in Germany. Of these 1,028 stations, 570 are operated by steam and have an output of 341,248 kilowatts. One hundred and nine are operated by water, with an output of 14,547 kilowatts. Ninety-four use gas engines and can deliver 10,050 kilowatts. There are two stations using Diesel motors; five, electrically driven, drawing power from other stations, one using wind power, and developing 220 kilowatts. These are simple stations. Of those using two or more systems of operating, there are 208 using water, with steam as a reserve. These have an output of 60,702 kilowatts. Sixteen combine water and gas; ten combine steam and gas; four, water and gasoline engines; four, water, steam and gas; one, gas, steam and gasoline, and one, water, steam and gasoline. There are three electrically driven, with steam as a reserve. Of these stations, twenty have outputs of over 5,000 kilowatts; twenty-seven between 2,000 and 5,000 kilowatts; twenty-eight between 1,000 and 2,000 kilowatts; fifty-seven between 500 and 1,000 kilowatts; 341 between 100 and 500 kilowatts, and 555 less than 100. These ratings do not include the accumulators. Taken together, these stations are connected to 5,687,382 incandescent lamps; 110,856 ten-ampere arc lamps, and motors aggregating 263,036 horse-power. Reduced to fifty-watt incandescent lamps, this represents 11,530,590 lamps, or 576,529 kilowatts. There are in use 247,366 meters. The greatest development in central station building in Germany took place in the years 1897 to 1900. The number of stations equipped during these years varied from 106 to 152. In 1901 the number constructed fell to eighty-eight, and since then has declined until it was only fifty-five in 1903, and eighteen for the first three months of 1904.—*Translated and abstracted from the Elektrotechnische Zeïtschrift (Berlin), January* 12.

Electric Plant for the Nilgiri, India, Cordite Factory.

The government of India has built a cordite factory in the Nilgiri hills, choosing this site because of the very even temperature of the climate. The site had a further advantage in being near abundant water power, and an electric plant was installed to utilize the Karteri falls, about three and one-half miles from the factory. A dam was constructed across the river which forms a reservoir containing seven and one-half million cubic feet of water. The area of the drainage basin is about ten square miles. The minimum flow has been found to be 181 feet per minute. This has never been reached since 1877. The supply would last forty-five days of twelve hours each, using 600 cubic feet per minute, and this is at least thirty per cent more water than will be required by the factory. With the present height of the dam it is probable that the factory could be worked for twenty-four hours a day for eleven months in the year, six days in the week, and twelve hours for the twelfth month. The dam has been designed so that another eight feet may be added to its height, which will enormously increase its storage capacity and allow a twenty-four-hour run for the entire year. The effective fall from the dam to the power-house below the falls is 624 feet, giving very nearly one horse-power for every cubic foot per minute. The pipes carrying the water from the dam to the power-house are twenty-four inches in diameter. They are of double-riveted steel, laid on concrete piers. The receiver pipe is placed back of the power-house, and is thirty inches in diameter and thirty-seven and one-half feet long. It is supplied with a relief valve and air vessels which act as cushions. The equipment consists of six turbines, each capable of delivering 230 horse-power. They are direct-connected to four three-phase, 125-kilowatt generators, delivering current at 5,000 volts between any pair of terminals. There are two smaller turbines of thirty-seven horse-power each, driving the exciters. The three-phase machines are run in parallel. The line from the power-house to the factory passes through hilly country and across two streams. It has one span across the river. The factory covers a large piece of ground, roughly one mile long and a quarter of a mile in breadth. The transformer house is placed in as central a position as possible. There are here high-tension and low-tension switchboards and four three-phase step-down transformers, each rated at 120 kilovolt-amperes. The voltage is lowered from 5,000 to 380 on the low-tension side, the pressure between any one phase and the neutral point being 220 volts. This is the pressure used for lighting the factory. The cables in the factory are laid underground on the solid system. They consist of three-core cables insulated with paper, covered with lead, and placed in earthen troughs which are then filled with pitch. There are eighteen motors in use at the factory. These are all of the three-phase type, and vary in output from three to forty-five horse-power. All the larger motors supply the starting resistances in the motor circuits. All the lamps are placed in special air-tight fittings, and all fittings and conduits are connected to the earth. The power-house and transformer house have been built large enough for an additional unit.—*Abstracted from the Electrical Review (London), February* 17.

Electrical Patents.

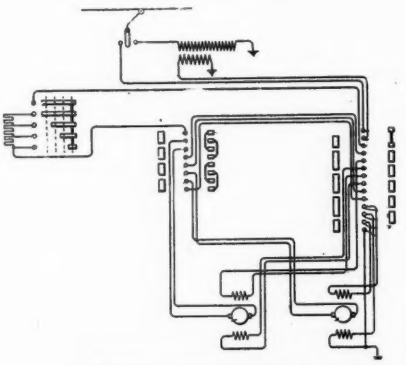
An improved alternating-current motor has been recently patented by Robert Lundell, of New York, N. Y. (782,863, February 21, 1905). The invention relates particularly to that class of alternating-current motors which is furnished with a commutator and which may be operated from a two-wire circuit. The object of the invention is primarily to construct a motor which may be self-starting with or without load. Other objects are to provide a motor which may be quickly reversed from a distance without undue complication, which will give a great starting torque and a high efficiency, and which will operate without injurious sparking at the commutator under various loads and speeds. It is a well-known fact that if a laminated field magnet is used in connection with an ordinary series-wound motor, the same may be made to run on a single-phase alternating-current circuit. It is also well known that an armature having a commutator can be made to run in an alternating-current field if certain coils in the said armature are



Alternating-Current Motor.

short-circuited upon themselves, though wholly disconnected from the primary circuit. Mr. Lundell has employed in his invention a combination of the principles which govern the operation of a series-wound motor and those which govern the rotation of a partly short-circuited armature, which is caused to rotate by the secondary or the induced currents in the short-circuited coils. The motor consists of a field magnet connected with a source of alternating-current supply and an armature having a winding, the coils of which are connected to a commutator. Means are provided for causing two or more adjacent coils of the armature winding to become traversed by currents from a source of supply, while the remaining sections of the other adjacent armature coils are subjected to the effects of local currents which are induced in the remaining sections of the armature winding.

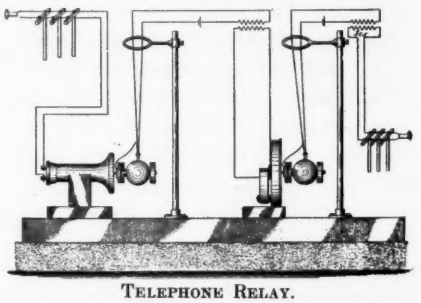
A motor-control system patented by Maurice Milch, of Schenectady, N. Y., has been assigned by him to the General Elec-



Motor-Control System.

tric Company, of New York (783,124, February 21, 1905). The invention relates to control of motors which are designed to be operated either from a direct-current or an alternating-current circuit. In this invention the motors and the control system are so designed that the motors may be satisfactorily operated without overloading when they are connected with the direct-current source. Each of a plurality of motors is provided with a field-winding, divided into a plurality of sections, and the control system is arranged to connect the field-winding sections of each motor in multiple when the motors are connected to the alternating-current source. The motors are connected, two in series, with the field-winding sections of each motor also connected in series when the motors are connected to the direct-current source. When used on railway work, a transforming device is provided on the car or train for reducing the alternating-current line voltage to a value such that each motor may be operated under an impressed voltage in the neighborhood of two hundred volts. The control system and the field connections of the motors are so arranged that the motors may be connected two in series for direct-current operation, with the field connections so changed that the motor will have speed and torque characteristics suitable for the particular case in hand. If the voltage of the direct-current source is in the neighborhood of six hundred volts, this object is accomplished more satisfactorily by dividing the field-windings of the motors into two sections, which are connected in series when the motors are operated as direct-current motors and in parallel when they are operated as alternating-current motors. This arrangement renders it possible to operate the motor as an alternating-current motor with a comparatively small number of ampere-turns on the field, a condition which is essential for efficient operation, and to double the number of field-turns when working on direct current. The motors are thus operated on direct current with the field strength great enough to prevent overloading and on alternating current with a field strength low enough to give the most efficient operation.

William W. Jacques, Boston, Mass., has secured a patent (781,207, January 31) for a telephone relay. The object of this relay is to restore to the telephone line the impulses which may have become attenuated by reason of the long distance of the line. The inventor has discovered that, by the use of two relays, each consisting of a receiving telephone and a microphone, the receiving telephone of the second being connected in circuit with the microphone of the first, the one relay having its parts delicately constructed and its normal pressure made exceedingly light, while the other relay has its parts more massive and its normal pressure heavier, the first relay being used essentially to magnify the telephone waves, while the essential function of the second is to correct the distortion of the first, fresh energy may be introduced into the circuit



Telephone Relay.

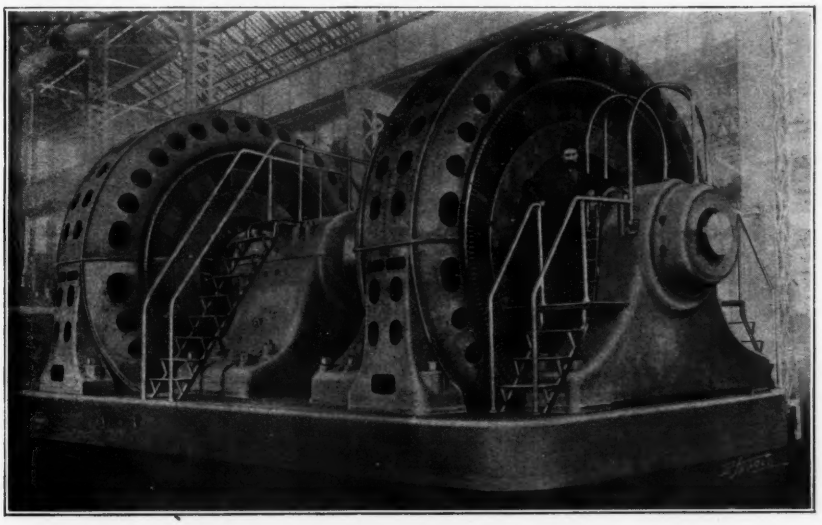
at one or more points. The apparatus consists essentially, then, of a "magnifying relay" and a "correcting relay," the combination of these two being designated by the inventor as a "compound relay." The invention further consists of means for so connecting two or more such compound relays to the wires of the main telephone circuit as to magnify and correct telephone waves transmitted over the circuit in either direction. Two compound relays associated together, one of which operates in one direction along the line, while the other operates in the other direction, are designated as a telephone repeater,

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Largest Electric Motor Ever Built.

The largest electric motor ever built is now being installed at the plant of the Shawinigan Water and Power Company, Shawinigan Falls, Quebec. This was recently constructed by the Allis-Chalmers Company at its electrical works in Cincinnati, and embodies in its design the characteristics of the Bullock alternators, which have proven singularly successful in their application. It is a synchronous motor of 8,000 horse-power. The rating of the generator operated by this motor, on standard specifications, is 5,750 kilowatts at 300 revolutions per minute. The combined machines, in addition to their enormous capacity, are remarkable for concentrating in an exceedingly small floor space a volume of 12,000 kilowatts.

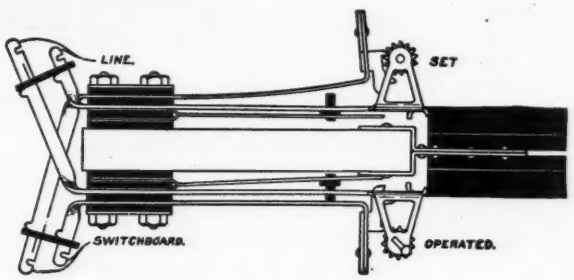


THE LARGEST ELECTRIC MOTOR EVER BUILT.

The photograph of the machines, which is shown herewith, was taken while they were being tested at the shops, by the Bohrend system, under full load conditions, corresponding to 7,200 kilowatts on the generator, with the expenditure of no more than 300 kilowatts in order to produce the same losses in the machine which exist under full load conditions. The working of the generator and motor forming the frequency changer at Shawinigan Falls will be carefully noted by electrical engineers in all parts of the world, and if it is as successful as the builder confidently anticipates, the result will be a valuable addition to existing data on the subject of alternating-current machinery.

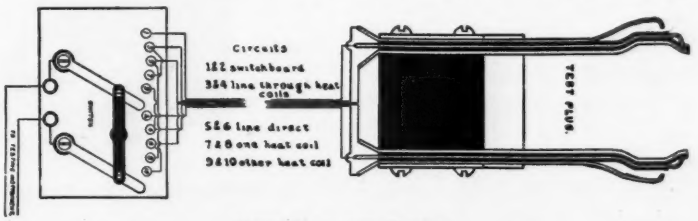
A New Cook Protector.

The latest central exchange protector manufactured by Frank B. Cook, Chicago, Ill., is shown in the accompanying illustrations. This is designated as No. 8, and while still adhering to the general lines of Cook's No. 444 protector, the apparatus is simpler in point of number of pieces per pair. The No. 8 protector has only four spring pressure contacts normally in series in the line circuit for each pair of protectors. Two of these contacts have two bearing points each. In restoring the coils to position after operating, it is only necessary to press the circuit-controlling spring back into position. All of the parts are mounted on a heavy metal bar, and this bar is intended to be permanently connected to earth. Neither bolt nor soldered connections are used in transposing the line and switchboard terminals.



SECTION OF NO. 8 PROTECTOR.

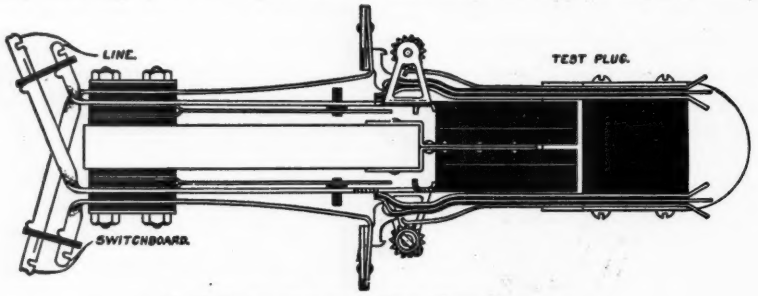
All of the alarm springs are connected to a common conductor. This is intended to be connected to an alarm signal, the other side of the signal being connected to earth. The alarm circuit is closed through only one contact, and while considerable trouble has been occasioned by this alarm circuit in some installations, the manufacturer states that this part of the apparatus has been so carefully worked out that it is now positive in operation. The heat coil, which is very sensitive, comprises a metal pin soldered by an easily fusible solder to a metal spool, upon which is wound several inches of silk-insulated resistance wire. The thickness of the insulation separating the wire from the spool is about 0.002 of an inch. The metal shell which encases the coil proper is formed over at both ends, completely encasing the fusible solder. The solder is thus protected from atmospheric exposure. As the heat-producing coil is concentrated around the fusible solder, the heat is applied directly to the solder, thus ensuring quick and uniform operation of the coil. The variations in outside temperature or air draughts will not affect the operation, the windings, spool and all vital parts of the coil being enclosed.



TEST PLUG AND SWITCH.

When the No. 8 coil operates it turns

on the pin through a small arc of a circle. This allows the solder to give slightly without actually breaking the solder connections, ensuring quick and permanent



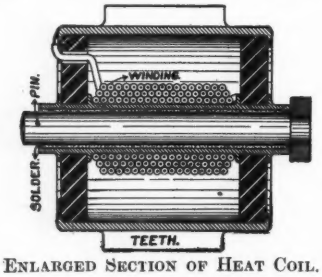
No. 8 Protector with Test Plug Inserted.

resoldering. The low fusing point of the solder ensures its melting before the winding will become hot enough to injure the coil.

The No. 8 heat coil and protector, when operated by either a heavy or a light current, opens the switchboard circuit, closes the alarm circuit, and grounds the line circuit, all in one operation.

One of the carbon lightning arresters is normally connected to the line and separated from the grounded carbon by mica not less than 0.005 of an inch thick. A potential of more than 350 volts is required to arc across this space. As an added protection, the carbon arrester always remains in circuit.

This No. 8 protector has been in an experimental state for about a year, but



Enlarged Section of Heat Coil.

exploiting it has been delayed until all defects could be remedied. The model has been submitted to prominent and expert engineers throughout the country, and has been received with a high degree of satisfaction.

With regard to the patents upon self-soldering protectors which have been issued, and which are not in litigation, Mr. Cook states that patent No. 776,219, issued November 29, 1904, covers broadly the self-soldering apparatus for switchboard protection which Mr. Cook has made. This patent will not expire until 1921. It is also stated by the manufacturer that he is not manufacturing any apparatus under the Rolfe patents.

A great many pairs of this new protector have already been sold. One of the most notable orders was for the new Cleveland (Ohio) Citizens' telephone exchange. This order was placed by the Automatic Electric Company, and calls for 8,000 pairs of protectors. Other orders have been received for exchanges throughout the country.

Improved Angle Wall Sockets.

The H. T. Paiste Company, Philadelphia, Pa., has recently improved the design of its "P-K" angle wall sockets.

Angle Socket with Key.

The new bases are of a tapering shape, that eliminates the awkward appearance of the old style, and make a much more graceful appearance when placed on the wall.

In addition, these bases are provided with "knockout" slots, of a very thin partition of porcelain, which can be easily knocked out with a small tool. This enables the wall socket to be used with both open or cleat type and concealed type of wiring. When used with the concealed

Keyless Angle Socket.

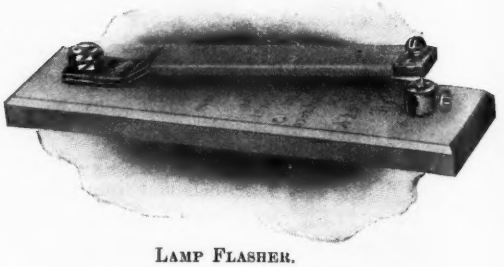
wiring there are no unsightly slots in the base.

The new wall sockets hold the lamp at an angle of sixty degrees from the vertical, an angle which gives greater diffusion to the light and a more graceful hang to the lamps.

Samples and bulletins will be sent on request to any one desiring them.

The "Firefly."

This is a unique and inexpensive little device for flashing a number of electric lamps, that has recently been invented by Dr. C. O. Schneider, 84 Adams street, Chicago. It will flash from one to three sixteen-candle-power lamps, one to six eight-candle-power lamps or one to twelve four-candle-power lamps on either direct or alternating current. The opening and closing of the circuit are caused by expansion and contraction of metals due to heat produced in a resistance coil by the electric current. The mechanism is



Lamp Flasher.

extremely simple, entirely automatic and noiseless in operation.

The contacts are heavy platinum and will last for many months as the spark is extremely small. This is due to a heating coil being so connected that it also acts as a shunt across the break to prevent an arc.

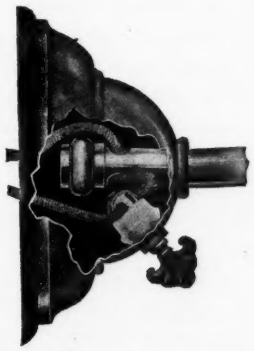
The "Firefly" will flash the lamps from fifteen to thirty times per minute and together they use less current than if the lamps were constantly bright. By means of an adjustment screw the interval between flashes can be regulated, thereby materially changing the effect. By turning this screw down the lamp will remain bright a greater length of time, while unscrewing it will have the effect of lengthening the period of darkness.

To connect the flasher it is inserted in one lead to the sign or attraction, while the other wire is undisturbed, thereby avoiding all possibility of short-circuiting. After the current is turned on it requires about a minute for the coil to warm after which it will cause alternate light and darkness, producing an action and animation that has an immense power of attracting attention.

To the White steam car belongs the honor of being the first automobile to take part in an inauguration parade. In the great pageant of last Saturday the Twenty-third Regiment, National Guard of the State of New York, used a White car as an ambulance. The car carried several of the surgeons and also the medical and surgical supplies and a stretcher. As it glided noiselessly along behind the regiment, it was greeted with liberal applause from the half million of spectators, in which the President enthusiastically joined.

Novelties for Fixture Work.

The very general application of electrical apparatus for the illumination of hotels, apartment houses, restaurants



CANOPY SWITCH.

and, in fact, all kinds of interiors, has created a demand for a type of fixture that would be easy to install and have the

KEY-ARM SWITCH.

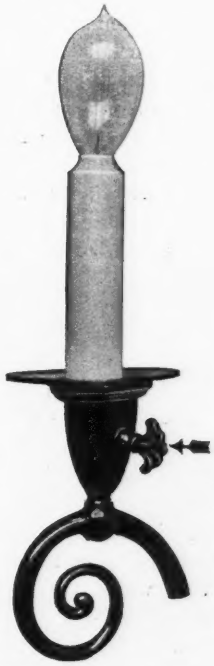
same self-contained features as the present-day gas fixture. To meet this demand, the Sarco Company, 906 Sixth avenue,

"NOSCRU" SWITCH IN BASE OF FIXTURE.

New York city, has created an adaptation of its "Noscru" key-arm switch, the applications of which may be seen from the accompanying illustrations. By the use of this key-arm switch the work of the fixture fitter is made very easy, and it is possible to make use of a wide variety of

ADAPTATION OF "NOSCRU" KEY-ARM SWITCH.

decorative forms. Where the "Noscru" key-arm switch is inserted in the chandelier line, it has a place analogous to the gas cock in the gas fixture. A valuable



ADAPTATION OF "NOSCRU" KEY-ARM SWITCH.

feature of this key-arm switch lies in its being absolutely screwless. The ends of the wires are passed through terminal bushings, making a long wiping contact with the blades of the key-arm switch. The very small size of the key-arm switch makes it applicable for an elaborate fixture, without in any way detracting from its symmetrical appearance.

The new "Noscru" canopy switch has an especially valuable feature to the chandelier fitter. This canopy switch can be used for any bracket or fixture by simply boring a five-sixteenths-inch hole in the canopy, body or base, pushing two wires through the holes in the porcelain body of the switch, bending them over, replacing the cap, and fastening the locknut.

The Sarco Company has made up these fancy fixtures in a large variety of forms. The selection is such that a suitable lighting fixture can be secured to satisfy the choicest requirement.

"Hiko" Electrical Specialties.

The Atlantic Manufacturing Company, Allenhurst, N. J., is the manufacturer of Hickley's "Hiko" commutator compound for carbon and copper dynamo and motor brushes. The company states that ten per cent greater output with less heating is secured with the use of this compound. The material stops sparking and lubricates the commutator. If the machine is started with a smooth commutator, the compound will keep it perfect, producing a desirable glazed surface, and increasing the life of the commutator and brushes.

The material contains no acid, and is not a conductor. It will not get between commutator segments and short-circuit them. It is also claimed that it will not in any way clog the brushes.

Another specialty which this company manufactures is the "Hiko" carbon brush. These brushes are especially adapted for street railway and other service where it is difficult or inconvenient to get at the commutator to apply a commutator lubricant. The company guarantees these brushes to give very much increased mileage in street railway service. There is no scratching of the commutator, and the edges of the brushes remain sharp and clean.

Small Motors Wanted.

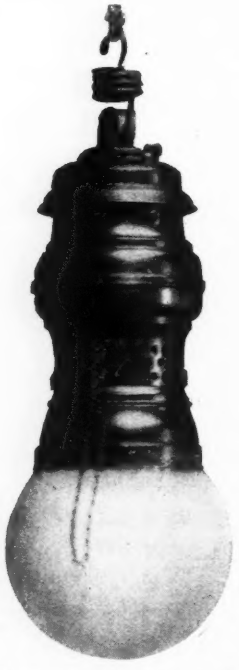
The Heald Machine Company, Worcester, Mass., has occasion to use quite a number of small motors, about one-fifth to one-quarter horse-power, running at about 3,000 revolutions per minute. The motor which the company has been using is not quite strong enough to suit, and the company is looking for a motor that will be in the neighborhood of seven inches in diameter and seven inches in length, not including the amount of shaft which projects for the pulley. These motors should be shunt-wound for 110 or 220 volts, either direct or alternating current.

New Form of Arc Lamp.

Louis F. Bogia, Jr., 146 North Seventh street, Philadelphia, Pa., has placed on the market a new form of electric arc lamp. In this lamp a number of features which have caused more or less trouble with prior forms of arc lamps have been eliminated. At the same time, those elements which have made for success in other lamp structures have been retained and modified or simplified, the idea being to secure a lamp which would be accurate in operation, reliable and certain at all times.

For controlling the feeding mechanism one substantially built combined solenoid and magnet is used. The movable core or armature, to which the carbon-feeding mechanism is rigidly attached, is lifted and lowered to a precise point of adjustment. The actuating mechanism is given the same strength and stability throughout its entire range, and every movement in feeding and regulating is powerfully aided and accelerated by this combination apparatus.

The actuating mechanism is extremely simple in design, and wear and tear is

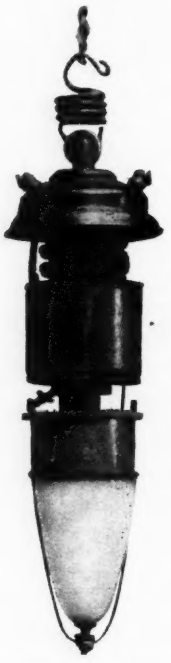


ARC LAMP WITH CASING AND GLOBE.

very much reduced, due to the fewness of the parts. With the exception of one essential hinge-joint in the clip there are no rotatory joints in the whole structure. Each movement is normally in a perpendicular direction, affording a minimum of friction.

When the current is cut off, the carbon pencils are brought together with such force that any foreign formation which may have accumulated at the carbon points is disintegrated and thrown off.

The contact device moves independently when the carbon feeds through the



INTERIOR OF ARC LAMP.

clutch. There are no wires or cables or thin sheet-metal contact brushes. When a new carbon pencil is being inserted in the lamp, the contact device rises with it, and, as it ascends, is arranged to rub firmly against the walls of the enclosing metallic tube. In this way the contacting surfaces are automatically cleaned at each trimming. In recarboning, also, both pencils pass through the bottom holder. This is of solid construction, and is bored to the proper size. Carbons which are large or out of line, and liable to cause trouble in the upper structure, can not be placed in the lamp.

The lower holder is provided with a gauge in the form of an encircling ledge or ring, marking the height to which the upper carbon stub—if used for the stationary pencil for the next turn—is placed in retrimming. This holder is also adjustable in length, so that various grades and forms of carbon may be employed.

The solenoid coil is fireproof and will not bake or burn out. It is also insulated from the heat of the arc by dead air spaces, these spaces being again separated by a non-conducting partition.

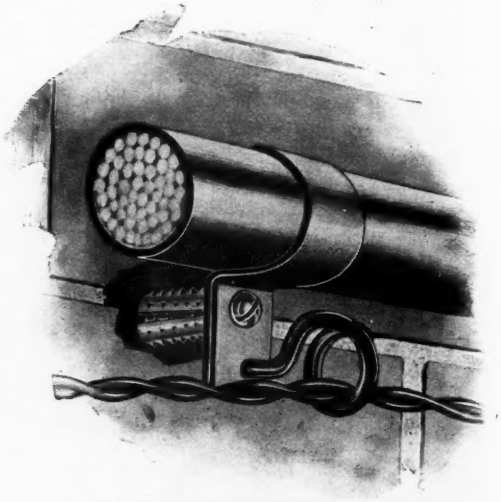
A New Cable Clamp.

The Diamond Expansion Bolt Company, 9 Murray street, New York city, has placed on the market a new cable clamp which has been named the "Long-Saut," the general arrangement of which is shown by accompanying engraving.

As will be seen, this arrangement provides a secure fastening for attaching pipe conduits or lead-covered cables to brick, stone, concrete or wood, as well as a support for bridle rings to carry bridle wires.

The clamps are heavily galvanized and made in four sizes for carrying lead-covered cable from three-quarters inch to two inches diameter. The bridle rings are made with machine thread for screwing into the clamp and can be furnished either galvanized, brass or enamel, and will not dent or injure the lead-covered cable in any way.

But one expansion shield (furnished with the clamp if desired) is required for fastening this clamp to the masonry. This alone is a great saving as it requires the drilling of one less hole than when spike dogs and separate bridle rings are used, besides the fact that the clamps cost less than the other articles. The expansion bolt ensures a more secure fastening than where cable dogs are used.



EXPANSION BOLT CABLE HANGER AND BRIDLE RING CLIP.

Cable clamps put up with Diamond expansion bolts can be taken down without injury to the conduit. Another advantage derived from the use of this clamp is that it can be used alike for attaching to wood or stone walls. The expansion shields used with the clamp can also be used with standard bridle rings where it is desired to set them separate from the clamps.

Enclosed Automatic Engine.

The Chandler & Taylor Company, Indianapolis, Ind., builds the enclosed automatic engine shown in the accompanying illustration. The frame of the engine is designed so that it will not only be strong and rigid enough to take care of the rated capacity of the engine, but also to have the strength and rigidity necessary to work under heavy overloads. The frame is also designed so that when the engine is assembled it will keep all the working parts in perfect alignment. It will, as well, catch and retain all oil used about the engine. The cross-head guides are bored out with the same boring bar which faces the end of the frame for the cylinder fit, thus ensuring perfect alignment of the cylinder with the bed.

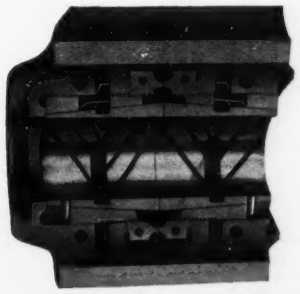
CHANDLER & TAYLOR ENCLOSED AUTOMATIC ENGINE.

The diameter of the shaft used in the engine conforms to the recommendations made by the committee of the American Society of Mechanical Engineers. Each shaft is made from a steel forging. The crank wheel is a casting, and the crank pin is cast integral with the wheel, and is reenforced by a steel core. The crank wheels are forced on the shaft under hydraulic pressure, and when in place, the shaft and crank wheel are turned true from the shaft centres.

The cross-head is a heavy casting of steel, and is provided with a large boss into which the end of the piston rod is screwed. The piston rod is held solidly in position in the cross-head by a heavy locknut. The shoes are wedge-shaped on the inner side next to the pin, and fit upon a similar wedge in the cross-head, the wear being taken by sliding one wedge upon another. The shoes when adjusted are held rigidly to the cross-head to prevent any motion between them.

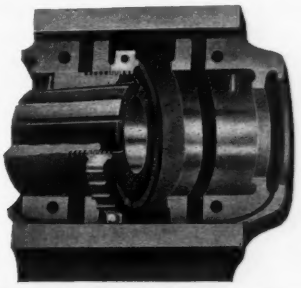
Direct-connected units require for the best service a peculiar construction of adjustment of the boxes for the crank shaft. The shaft must always be maintained concentric with the field frame of the generator, or otherwise the armature would be out of centre with the pole-pieces, and this would cause sparking at the commutator and other troubles.

To overcome this result, the Chandler & Taylor Company has embodied in its design what it calls a "self-centering and self-oiling" main crank bearing. As this main crank bearing, next to the crank disc, receives the brunt of the work, it must be arranged so that it can be adjusted very accurately when wear occurs. The bearing proper of this box is made of babbitt metal sleeves which completely surround the journal, and which are made cone-shaped on the outside surface. The larger bases of these cones butt together in the centre of the bearing. These sleeves are completely surrounded by some cone-shaped cast-iron wedges which are threaded on the outside surfaces, and which can be drawn together toward the centre of the bearing by some split nuts, which completely encircle them. When an adjustment is made, the nuts are turned, the wedges drawn together, and the sleeve thereby compressed equally at all points around the journal; and for this reason, the centre of the shaft is maintained in the same line in which it was originally set up. In addition to this adjusting feature, the shells are cored out so that an oil chain gives the bearing a copious supply of oil, and if there is any excess of oil supply, it runs out of the bearing and is returned by proper grooves to the oil well below. The bearing is perfectly rigid, because all of the parts are made interchangeable and fit together metal to metal, without any intervening liners.



SELF-CENTERING MAIN CRANK BEARING.

One of the most important features of this bearing is that it is possible to renew the bearing shells without removing the shaft from the engine. After the cap of the bearing is taken off, the crank shaft is simply moved enough to relieve the pressure on the bottom shells, and the old ones are removed and new ones slipped in place. The shaft immediately comes to its original central position when new shells are in place.



CAST-IRON WEDGES IN SELF-CENTERING BEARING.

The pedestal bearing furnished is what is generally known as the dynamo type, and consists of a box mounted on three heavy cap screws, which makes the bearing self-aligning. Also, it can be adjusted for any wear due to the weight of the wheel and armature.

The governor is of the Rites type. The valve used is a double-ported gridiron valve, and is extra light and quickly acted upon by the governor. The valve is perfectly balanced, and is so arranged that it will lift off of the valve seat and automatically relieve the pressure if an undue quantity of water should collect in the cylinder.

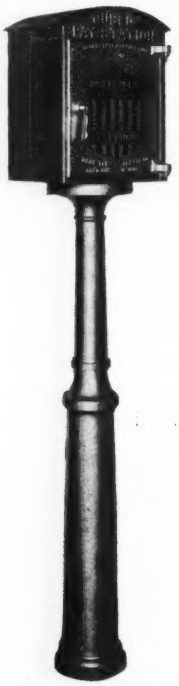
The Chandler & Taylor Company reports that one of its 100-kilowatt engines has been operated on less than seventy-five cents worth of oil in a week's continuous run. This includes both cylinder oil and engine oil.

OPEN AIR TELEPHONE SERVICE.

BY GEORGE A. LONG.

With the rapid development of the telephone and the various uses to which it has been put, probably one of the greatest strides made in recent years to serve the public was the introduction of the street corner pay station.

It is but a few years ago that the public



PUBLIC PAY STATION TELEPHONE, CLOSED.

pay station made its appearance in drug stores, depots, etc. Now, however, there have been installed over one hundred and thirty thousand pieces of apparatus of this type, and they have proven one of the best paying branches of telephony. There is none more profitable to the operating company and more satisfactory to the general public than the automatic pay station, which comprises part of the equipment of practically all progressive companies; the larger companies having their superintendent of pay stations, and he his force of assistants.

In all cities throughout the country the public pay-station sign is to be found and the operating company does not consider its territory properly covered unless all public places are provided with stations of this sort. The Bell companies have obtained excellent financial results with these instruments and collections amounting to as high as $250 per month have been made from a single station.

The public, however, are not supplied with the telephone until they can have it as handy as the mail box.

In all cities and towns where there is telephone service a person familiar with conditions can select numerous locations where the street pay station should come in for a large amount of business. The installation of such sets has so far proved entirely satisfactory to the companies that have added them to their equipment. In some cities the operating company has arranged with the city officials, in consideration for the privilege of placing street stations, to give the public free use of them for calling the police, fire department or hospitals, it being understood at the telephone exchange that all emergency calls from these stations can be made without charge.

There is no reason why these stations should not supersede the police telephone system now in use, if the operating company could make proper inducements to the city. The police could send in their reports to headquarters over these public stations and if such an arrangement should come about there would be no more boxes on the street than at present

PUBLIC PAY STATION TELEPHONE, OPEN.

and the blue police box now so common would be a thing of the past, which would mean a large saving to the city and a revenue to the operating company which alone would prove a good investment on the station so installed.

The advantage of these stations in case of fire, especially at night, is obvious. With the fire-alarm boxes now in use, a person wishing to send in an alarm, has to awaken his neighbor to get the key and during all this time the fire is making headway. With the street telephone it would be possible to call fire headquarters direct, and inform them of the location of the fire.

These stations should prove convenient in the residential section of any city where there are no stores, and in the public parks where a person out driving can get in touch with the centre of the city at any time. To Bridgeport, Ct., is given the credit of being the first to install stations of this type, it having had the same in use for over three years, these being the first stations installed in the United States if not in the world. The receipts have been satisfactory from the start. During the past few months, however, several of the larger telephone companies throughout the country have placed orders for these instruments and indications point to a large demand in the near future.

These stations are keyless and by turning the handle the door can be opened. Inside is to be found a standard pay station of gravity principle, which means the user has no buttons to push or levers to pull. The user calls central and if the desired connection can be had the operator requests the deposit of a coin of the proper denomination for said call. The door of this station is also of the gravity type and is self-closing and on the inside of it is to be found a directory.

No special wiring is required for these stations and they can be placed on the iron post which is hollow to allow for underground wires, or they can be placed on the regular telephone pole. The maintenance is said to be very light.

They are finished in aluminum which will stand the weather well and will always look neat and attractive in appearance. They should also afford the telephone companies a profitable means of advertising.

Reynolds-Corliss Engines.

The Allis-Chalmers Company, Milwaukee, Wis., in catalogue No. 120, describes Reynolds-Corliss engines. In addition to the descriptive matter and tables of sizes there are numerous fine illustrations of different types of Reynolds-Corliss steam engines. The descriptive matter and illustrations include heavy duty engines, Reliance-Corliss engines, girder frame engines, vertical engines, horizontal-vertical engines, compound engines, direct-connected engines, rolling-mill engines, blowing engines and air-compressors.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

PORTO RICAN RAILROAD FAILS—It is announced that the executive council of San Juan, Porto Rico, has annulled the franchise granted on March 3, 1903, to the Vandegrift Construction Company, of Philadelphia, Pa., to build a $3,000,000 electric railroad from San Juan to Ponce.

NEW ORLEANS, LA., TELEPHONES—It has been reported that steps are being taken for the establishment of an independent people's telephone company in New Orleans, La. It is stated that the company will be made up entirely of small stockholders, no one interest to hold more than ten per cent of the capital stock. The plans are for a corporation with a capitalization of about $1,000,000, with a modern working plant.

CHICAGO CITY RAILWAY POWER-HOUSE—Plans for the erection of a large new power-house for the Chicago City Railway Company, to cost about $5,000,000, are being prepared by the engineering department of the company. The power-house will probably be built near the south branch of the Chicago river, and north of Twenty-second street. It is said that construction will begin as soon as T. E. Mitten, the newly elected operating head of the road, assumes charge.

NORTH AMERICAN COMPANY TO INCREASE ITS CAPITAL—The directors of the North American Company, St. Louis, Mo., have recommended an increase of capital from $17,000,000 to $30,000,000. The company has recently decided to purchase all the stock of the Laclede Gas Light Company and the Union Electric Light and Power Company, of St. Louis, Mo. An additional contract has been entered into, providing for the purchase of a large interest in the United Railways Company, of St. Louis.

GREAT BRITAIN TO BUY UP THE TELEPHONE TRUST—It is announced that the British postmaster-general has made an agreement with the National Telephone Company to take over its business and buy its plant after December 31, 1911. The price to be paid for the business is to be settled by arbitration. Three-quarters of the whole purchase money may, at the option of the government, be paid by means of an annuity for a term not exceeding twenty years. The postmaster-general also retains certain powers, enabling him to reject the purchase of any plant unsuitable for the carrying on of the business.

NEW JERSEY TELEPHONE MERGER—Papers merging the Delaware & Atlantic Telegraph and Telephone Company, the Trenton Telephone Company, the South Jersey Telephone Company, the Hopewell Telephone and Construction Company and the Bay Shore Telephone Company, have been filed at Trenton, N. J. A charter of incorporation has been granted to the consolidated company, which will operate under the name of the Delaware & Atlantic Telephone Company, with a capitalization of $400,000. The officers and directors are: president, Union N. Bethell; secretary and treasurer, Winfield A. Piersall, and James E. Mitchell, Theodore Spencer, William T. Westbrook and H. S. Huidekoper.

EXTENSIVE SUBWAY PLANS RECOMMENDED—The committee on plans and contracts of the Rapid Transit Commission, New York city, has formulated plans for more than a dozen new subway and elevated lines, with a number of alternate routes, in and around the city of New York. The proposed routes tap the Bronx, Westchester, Williamsburg, East New York and Staten Island, besides providing for underground rapid transit on the east side of Manhattan borough and across town. To build all of these lines would cost approximately $250,000,000. It is expected that the tunnel construction along the routes finally to be chosen from the tentative plans will cost about $120,000,000.

AN EXTENSIVE ELECTRIC POWER PLANT FOR NORTHERN INDIA—A power plant is to be established at Rampur, India, on the Jhelum river. With the use of a six-mile feeder channel it has been found that it is possible to get a fall of 450 feet at this point. With the minimum flow in the Jhelum river it will be possible to obtain 100,000 horse-power. When the installation of the power station is completed it will be possible to operate the Kashmir Railway electrically along its whole length of 180 miles, and also provide power for industrial purposes in Srinagar, Abbottabad, Murree and Rawalpindi. An even more important use, however, will be the utilization of the power in operating electrical dredges for the purpose of deepening the river in the Kashmir valley. This application will tend to minimize the effects of floods, which under the present conditions devastate the country periodically. It will allow of the reclaiming of a large tract of land, and will also permit storage of water in the Woolar lake, for sale to the Punjab irrigation department.

EXTENSIVE IMPROVEMENTS TO LONG ISLAND RAILROAD SERVICE—It is stated that approximately $90,000,000 will be spent by the Long Island Railroad Company, the Pennsylvania Railroad Company and the connecting railroad companies, for the betterment of transit facilities for passengers and freight to and from Long Island. The tunnel from Jersey City to Long Island City will cost $40,000,000. The contemplated improvements in the Long Island Railroad will cost $40,000,000, and $10,000,000 will be spent in building a connecting railroad by way of a bridge over Hell Gate and Ward's Island, for the joint use of the Pennsylvania, the Long Island and the New York, New Haven & Hartford railroads. The Long Island Railroad Company is hastening the work of electrification, and expects by June 1 to operate over forty-five miles of its length. The company is having built 122 steel motor cars, similar to those used in the rapid transit subway in Manhattan. Two portable substations, constituting an interesting development in railroad engineering, will be experimented with. These portable substations will be used to reenforce any permanent substation in an emergency caused by a rush of traffic in any particular section. They will increase from two to six times the capacity of any station. Each of the portable substations consists of one 1,500-kilowatt rotary converter with three transformers and a blower, and complete switching apparatus, all carried in a fireproof steel car.

ENGINEERING SOCIETIES.

NEW YORK ELECTRICAL SOCIETY—The next regular meeting of the New York Electrical Society will be held on Wednesday, March 15. Dr. E. F. Roeber will lecture on "Recent Developments in the Electrometallurgy of Iron and Steel," and the well-known authority, Dr. Paul L. T. Héroult, of La Praz, France, will lecture on "Making and Refining of Steel in the Electric Furnace."

ELECTRICAL SOCIETY OF PENNSYLVANIA STATE COLLEGE—The Electrical Society of Pennsylvania State College met on Wednesday evening, March 1. A paper on "The New York Central Electric Locomotives" was read by C. N. Goodman. A paper entitled "Currents in Telephone Receivers" was read by C. E. Govier. P. M. Jordan described Westinghouse direct-current motors, and an article on "Air in Electric Subways" was presented by B. W. Kline.

MADISON BRANCH, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—On Thursday evening, March 2, the Madison, Wis., branch of the American Institute of Electrical Engineers took up for discussion the papers presented at the New York meeting of the Institute in January. The paper on acyclic generators was carefully abstracted by O. M. Jorstad, a graduate student at the University of Wisconsin. He also read an abstract of the New York discussion. A. Kellar discussed this subject from the standpoint of the manufacturer, as well as the operator. He compared the homopolar dynamo with the commutator type for different voltages and capacities, showing by curves the relation of the probable costs in each case. Mr. Moultrop's paper on central station design was abstracted by C. A. Hoefer, and the discussion opened by R. F. Robinson.

TELEPHONE AND TELEGRAPH.

PEKIN, ILL.—The Pekin Telephone Company will build a toll line from Havana to Lewiston, and from Atterbury to Virginia.

WHEELING, W. VA.—The Pultney Telephone Company, located at Shadyside, has been acquired by the Belmont Telephone Company.

DETROIT, MICH.—The Michigan State Telephone Company will soon begin erecting a rural telephone line through Armada.

BEATRICE, NEB.—The Nebraska Telephone Company has completed a new telephone line, running five miles east of Beatrice.

HUNTINGTON, IND.—The Central Union Telephone Company has made known its intention of establishing an exchange at Huntington.

EDWARDSVILLE, ILL.—The Central Union Telephone Company has erected another country line on the Springfield and Bethalto roads.

GADSDEN, ALA.—The work of putting in a new telephone exchange at Boaz is almost complete, and the line from Albertsville will be rebuilt at once.

ANN ARBOR, MICH.—The Washtenaw Home Telephone Company has increased its capital stock from $250,000 to $300,000. It is building an exchange at Ypsilanti.

ASHLAND, KY.—The Southern Bell Company will build a line from Wayne, W. Va., to Fort Gay, and up Tug river to Matewan. The line will cross the river at Ashland, and connect with Louisa.

ATLANTIC, IOWA—A number of farmers north of Atlantic, among them being William Lamb, A. Pellett, D. E. Milford, Charles Bartley and O. M. Becker, have organized the Atlantic Mutual Telephone Company.

BURLINGTON, IOWA—Two hundred thousand dollars will be expended by the Mississippi Valley Telephone Company in rebuilding lines and for new equipment at Burlington, Keokuk, Fort Madison, Wapello and Muscatine.

ABERDEEN, S. D.—The Dakota Central Telephone Company will extend its line to Pierre from Gettysburg. It will then have a copper metallic circuit from Bowdle to Pierre. A new line will also be built from Ipswich to Faulkton and Miller.

DUQUOIN, ILL.—The Duquoin Telephone Company has elected the following officers: president, Harry C. Miller; vice-president, Mark C. Brookings; secretary-treasurer, R. O. Lehn; manager, E. J. B. Aldridge; directors, R. O. Lehn, H. C. Miller, Mark C. Brookings, E. J. B. Aldridge.

FORT SCOTT, KAN.—The Bell Telephone Company, which some time ago secured a controlling interest in the Mutual Telephone Company, of Fort Scott, has arranged a settlement with the minority stockholders of that company and will consolidate the two plants. A new exchange will be put in at a cost of $75,000, and connections arranged with local rural lines.

ANDERSON, IND.—The stockholders of the Delaware & Madison County Telephone Company have elected directors, the board organizing with A. L. Johnson, Muncie, president; J. J. Netterville, Anderson, vice-president; Thomas Bromley, Muncie, secretary and general manager. The company has 4,243 telephones operating in Muncie, Anderson, Elwood and Alexandria.

REDLANDS, CAL.—Work has been commenced by the Sunset Telegraph and Telephone Company on its new line to Yuma, where connections will be made with a line to be built by the Consolidated Telegraph, Telephone and Electric Company, with headquarters at Phœnix. The two companies have arranged to connect with the Southwestern Company, operating in Texas.

NEW ALBANY, IND.—The Mohawk Valley Independent Telephone Company has been organized by the farmers residing between Fredericksburg and Palmyra, on the Paoli pike, north of New Albany. The line will probably be connected with the telephone system in New Albany. The officers are as follows: president, Jonathan Boston; secretary, A. L. Rudolph; treasurer, Clint Fouts.

SALT LAKE CITY, UTAH—The Grand Valley & La Sal Telephone Company has started work on a line from Cisco, *via* Richardson, Castleton, Basin, and to Gold Basin, a distance of about fifteen miles. It is proposed to have this line completed and in operation for spring business. It is also proposed to extend it from Miners' Basin into Beaver Basin, and from Gold Basin to the Paradox-La Sal mines.

FREMONT, OHIO—The annual meeting of the Fremont Home Telephone Company was held recently, and these directors were elected: S. Brinkerhoff, C. M. Russell, Joseph Horn, James Hunt, A. W. Overmyer, T. M. Brush, A. E. Lord. The directors elected: president, S. Brinkerhoff; vice-president, C. M. Russell; secretary, Joseph Horn; treasurer, J. M. Sherman. The company added 357 new telephones during the year, and now has 1,300 connected.

MONMOUTH, ORE.—The annual meeting of the Luckiamute Rural Telephone Company stockholders resulted in the election of the following officers: J. H. Hawley, president; James Helmich, vice-president; J. J. Thurston, secretary; J. H. Hawley, J. A. Withrow, J. J. Thurston, W. E. Williams and James Helmich were elected a board of directors. The wire and poles from Monmouth into the Luckiamute country are the property of this company, and are used by both the Independent and Pacific States systems.

YOUNGSTOWN, OHIO—At a meeting of the directors of the Youngstown Telephone Company, at Cleveland, two Youngstown men were reelected directors. They were C. Y. McVey and George G. King. The directors elected Mr. McVey vice-president. Mr. King is the local manager. The other directors elected were F. S. Dickson, who was elected president; J. B. Hogue, elected secretary; R. W. Judd, elected treasurer, and W. L. Carey, Jr., and M. B. Overley. A dividend of four per cent was ordered on the common stock at the rate of one per cent quarterly.

ANOKA, MINN.—At the annual meeting of the stockholders of the Rural Telephone Company, of Hennepin County, held at Osseo, the company was reported to have 102 patrons, ninety miles of wire, and six toll lines. The exchange is in Osseo, and lines run into Corcoran, Hassan, Maple Glove, Brooklyn, Champlin, Osseo, Rogers and St. Michaels. The stockholders chose as directors for one year O. S. Miller, P. Heckleman and G. H. Smith; for two years, A. P. Hechtman, B. V. Dibb and Edam Schmidt; for three years, Elmer Owen, H. E. Punt and Henry Berning.

BALTIMORE, MD.—The Delmarvia Telephone Company, of Wilmington, Del., is projecting two lines, one covering the eastern shore of Maryland and the other the state of Delaware. The objective point of both lines is Salisbury. At this point these lines will connect with the Pocomoke Telephone Company, which operates below Salisbury, and the two will give a complete local service on the whole peninsula, and will as well have a long-distance service between Wilmington, Philadelphia and Baltimore. The new lines will operate in connection with the Maryland Telephone Company.

DENVER, COL.—Extensions and improvements for the Colorado Telephone Company were ratified at a recent meeting of the stockholders and directors. The sale of $1,200,000 of treasury stock authorized at a special meeting in January for the purpose of improvements was indorsed, and it was agreed that $200,000 of this money should be used for extending the Colorado line into New Mexico. Officers elected were: E. B. Field, president; Alonzo Burt, of Milwaukee, vice-president; H. W. Bellard, secretary and auditor; E. B. Field, Jr., treasurer. The following directors were elected: E. B. Field, A. V. Hunter, of Leadville; W. L. Graham, of Pueblo; F. P. Fish, of Boston; E. S. Kassler, Crawford Hill, Joel F. Vaile and Philip Feldhauser.

COOPERSTOWN, N. Y.—The Otsego Home Telephone Company has purchased the Winfield Telephone Company and the Wharton Valley Telephone Company. The first named is a small company operating between Richfield Springs and Winfield. The Wharton Valley company is one operating lines in the northern part of Otsego County, through the towns of Edmeston, South Edmeston, West Edmeston, North Edmeston, Burlington, West Burlington, Burlington Flats and Garratsville. The purchase of the two companies practically completes the Otsego Home Telephone Company's connections throughout the northern part of Otsego County and the southern part of Herkimer County, and gives it about one hundred and sixty additional telephones, with about sixty additional miles of toll lines.

LEGAL NOTES.

COURT AND COUNCIL DENIED RIGHT TO FIX TELEPHONE RATES—The Supreme Court of Ohio has rendered a decision in the case of the state against the Toledo Home Telephone Company, holding that, in granting franchises, there is no power either in the probate court or the city council to fix the rate which the telephone companies may charge for service. The decision of the court is that the demurrer to the answer is overruled, and the petition is dismissed.

CINCINNATI STREET RAILWAY FRANCHISE UPHELD—The Supreme Court of Ohio has handed down a decision which sustains the validity of the franchises under which the Cincinnati Street Railway Company operates. The franchises rest upon the so-called Regers fifty-year franchise act, which was passed eight years ago, and repealed by the next legislature. The court, in its decision, reversed the decision of the lower courts against the railway company, and dismissed the petition. This brings to an end, in favor of the railway company, the long litigation over the franchises purchased by Theodore Horstman.

FEDERAL COURT ENJOINS NATIONAL COMPANY IN ERBEN PATENT SUIT—Judge Seaman, in the United States Circuit Court for the Eastern District of Wisconsin, in an opinion handed down on February 24, after a preliminary hearing, granted an injunction against the National Electric Company in the suit brought by the General Electric Company, alleging infringement of the Erben brush-holder patent No. 705,055, in the manufacture by the defendant company of brush-holders for generators and motors. The Westinghouse Electric and Manufacturing Company was interested in the suit as licensee under the Erben patents.

HALF-FARE LAW FOR SCHOOL CHILDREN DECLARED CONSTITUTIONAL IN MASSACHUSETTS—The Massachusetts Supreme Court has handed down a decision declaring constitutional the legislation under which street railway companies are required to carry pupils of the public schools to and from school at half the regular fare. The decision was in the case of the commonwealth against the Interstate Consolidated Street Railway Company. The railway company contended that the statute was unconstitutional, as it did not apply to all pupils of all schools, but only to those of the public schools. The court held that the legislature has the power to concern itself with the transportation of children to the public schools in the interests of popular education, as it provides the children with books and other necessaries.

DECISION IN TESLA PATENT SUIT—Judge Buffington, in the United States Circuit Court for the Western District of Pennsylvania, on February 24, handed down a decision dismissing the plea of estoppel interposed by the Diamond Meter Company, of Peoria, in the suit brought by the Westinghouse Electric and Manufacturing Company against the Jefferson Electric Light, Heat and Power Company, of Punxsutawney, for infringement of the Tesla split-phase patents Nos. 511,559 and 511,560, in the use of Scheefer induction meters for alternating currents manufactured by the Diamond company. An injunction was granted on the following day restraining the Jefferson company from the further use of these meters. The Diamond Meter Company undertook the defence of the case against the Jefferson company on the plea that it had been a party to the defence in a similar suit brought some years ago by the Westinghouse company against the Catskill Illuminating Company, in which Judge Lacombe's decision sustaining the complainant was reversed by the Court of Appeals, which held that the validity of the patents in question had not clearly been established in the hearing in the lower court. The validity of the patents has since been established in a number of actions in different states. The defence in the suit against the Jefferson company rested on the plea of estoppel entered by the Diamond company, and Judge Buffington, in holding after a final hearing that the Diamond company had not appeared openly as a party to the defence in the Catskill case, ordered that a decree of infringement be entered against the Jefferson company.

NEW PUBLICATIONS.

THE EFFICIENCY AND PRACTICAL APPLICATION OF USEFUL ILLUMINANTS—Dr. W. Wedding, professor at the Technical High School, Berlin, has issued, in pamphlet form, his recent paper on the efficiency and use of illuminants, which appeared in the *Journal fur Gasbeleuchtung und Wasserversorgung* during January.

THE WORK OF THE INTERSTATE COMMERCE COMMISSION—This book, by H. T. Newcomb, has been printed, together with reprints of certain editorial and other articles which throw light upon the proposed amendment to the interstate commerce law. The articles have been taken from the *Railway Age*, the *Railroad Gazette* and the *Commercial and Financial Chronicle*.

INTERSTATE COMMERCE BRIEF AS TO PROPOSED NEW LEGISLATION—This is a brief prepared by Samuel Spencer and David Wilcox, and filed with the Committee of Interstate and Foreign Commerce of the House of Representatives, January, 1905. It takes up the propaganda for further legislation, past and present proposed changes in the law, and discusses these proposed changes.

OFFICERS, DIRECTORS, COMMITTEES, MEMBERS, ETC., OF THE MERCHANTS' ASSOCIATION OF NEW YORK—The Merchants' Association of New York has issued a booklet giving the officers, directors, committees, members, annual reports, by-laws, etc., of this association. The book contains eighty pages, and tells the purposes of the association and the work done during the past year.

WATER SUPPLY AND STATISTICS OF THE UNITED STATES GEOLOGICAL SURVEY—The Department of the Interior, Washington, D. C., has issued five papers dealing with the water supplies of the United States, as follows: "Water Powers of the State of Maine," by H. A. Pressey; "Normal and Polluted Waters in Northeastern United States," by M. O. Leighton; "Report of Progress of Stream Measurements for 1902," by F. H. Newell; "Report of Progress of Stream Measurements for 1903," by J. C. Hoyt; "Contributions to the Hydrology of Eastern United States," by Myron L. Fuller and others.

PROCEEDINGS OF THE TENTH ANNUAL MEETING OF THE OHIO ELECTRIC LIGHT ASSOCIATION—This book gives the proceedings of the tenth annual meeting of the Ohio Electric Light Association, which was held at Sandusky, Ohio, August 16 to 18, inclusive, 1904. It gives the officers and members of the association, and also the papers read at the meeting, together with the president's address. The papers presented were "The Day Load as a Factor in Central Station Earning Capacity," by L. B. Holt; "Transformer Testing for Central Stations," S. E. Johannesen; "Relation of the Supply House to the Central Station," P. R. Boole; "Relation of Electric Heating Devices to Central Stations." H. W. Hillman; "The New Luminous Arc Street Lighting System," H. W. Hillman; "Notes on Incandescent Street Lighting," K. C. Randall; "Notes on the Incandescent Lamp," E. H. Haughton; "The Steam Turbine and Its Use," E. C. Crocker; "The Instrument Equipment of a Testing Department," F. Conrad; "Graded Costs of Electric Supply," M. E. Turner; "Points for Consideration When Purchasing Series Alternating-Current Lamps," G. Brewer Griffin; "Unaccounted-for Current," W. E. Richards; "Joint Use of Poles by Public Service Corporations," G. S. Gaskill.

AUTOMOBILE NOTE.

THE AUTOMOBILE AND THE LAW—On Tuesday evening, March 7, at nine o'clock, Mr. W. W. Niles addressed the Automobile Club of America on the "Automobile and the Law," setting forth the rights, duties and liabilities of the automobilist.

ELECTRIC RAILWAYS.

VISALIA, CAL.—The contract for the construction of the electric road from Exeter to Lemon Cove by the Visalia Electric Railroad Company has been let.

ATHENS, GA.—The Athens Electric Street Railway Company will at once install a large steam plant, to be used when the water of Middle river is not available.

PERU, IND.—Peru township has voted $20,000, and Richland township $10,000 subsidies for the Peru & Warsaw interurban line, promoted by Solomon C. Dickey, of Indianapolis.

MILWAUKEE, WIS.—A franchise has been obtained for the construction of an electric road from Genesee, Waukesha County, to Waukesha for both freight and passenger traffic. Work will begin soon.

MEMPHIS, TENN.—An extension of its franchise has been granted to the Memphis Street Railroad Company, and $1,000.000 will be spent in extending the lines, the work to be completed by December 1.

NEW ORLEANS, LA.—The franchise for an electric street railway, to be operated in Jefferson parish, from the Orleans parish line to the Texas Pacific Railroad depot in Gretna, has been sold to Leigh Carroll and James Dickins.

ATTICA, IND.—Logan has voted a subsidy of $33,000 to the proposed interurban line from Tipton, through Frankfort, to Attica, by a majority of 264. The same proposition was defeated more than a year ago by a majority of ninety-six.

ELKHART LAKE, WIS.—The power plant for the Sheboygan-Elkhart Lake Railway and Electric Company has been completed. The cost of the plant was $200,000. As soon as the winter is over construction work will be begun. The grading has been completed between Elkhart Lake and Plymouth.

CANON CITY, COL.—At a special meeting of the Canon City city council a franchise was granted to J. W. Baumhoff, of St. Louis, to build, equip and maintain an electric railway system, the franchise to extend over a period of twenty-five years. The concession carries with it the privilege of conveying freight cars over the lines within the city limits.

MAHANOY CITY, PA.—Mahanoy City, Shenandoah, Ashland and Frackville capitalists are forming a company to purchase the Lakeside & Schuylkill trolley lines, operating between Mahanoy City and Shenandoah, and Mahanoy City and Locustdale. The Lakeside line will be extended to Tamaqua, thus connecting Mauch Chunk with Shamokin by trolley.

SALISBURY, N. C.—The Salisbury & Spencer Railway Company has sold an interest in its system to the American Gas and Electric Company, of Providence, R. I., for $150,000, and it is stated that the line now under construction between Salisbury and Spencer will be completed and put into operation at once, and an electric light system will also be installed in Spencer.

BOWLING GREEN, OHIO—By the completion of the eastern extension of the Lake Erie, Bowling Green & Napoleon Electric Railroad from Pemberville to Woodville, through passenger traffic is established between Bowling Green, Cleveland and other eastern points by trolley lines. Connection is also made with cars for Toledo and Findlay over the Toledo, Urban & Interurban Electric line.

BENTON HARBOR, MICH.—The St. Joe River Traction Company, originally formed to connect Benton Harbor, Niles and Dowagiac, will be extended north from Benton Harbor to Kalamazoo, with a spur to Sister Lakes. Immediate steps will be taken to secure a right of way. The line to Kalamazoo will be fifty miles long, and will tap a rich farming country heretofore untouched by a railway line.

MIDDLETOWN, N. Y.—The Middletown-Goshen Traction Company was sold recently at foreclosure in the action entitled the Farmers' Loan and Trust Company, as trustee, plaintiff, against the Middletown-Goshen Traction Company. It was bid in by Edward R. Sponsler and William H. Sponsler, of Philadelphia, for $150,000. The same parties also purchased the Middletown-Bloominburgh Electric Railway.

PHILADELPHIA, PA.—Judge McPherson, in a decree handed down in the United States Circuit Court, of Philadelphia, has ordered the sale of the West Chester, Kennett Square & Wilmington Electric Railway Company's line at public auction by Bayard Henry, the receiver. Under this order the entire line will be sold, including rights, rolling stock, power-house, car barn, tracks, poles and wires.

BOSTON, MASS.—Boston and Worcester stockholders have authorized the issue of 1,000 shares of preferred and 1,500 shares of common, the proceeds to be used to retire floating debt incurred for the purchase of stocks of the operating companies. The report for the quarter ended December 31 shows an increase of $12,683 in gross, and an increase of $7,118 in balance for dividends. Earnings since January 1 have increased heavily.

YORK, PA.—A meeting of residents of Fawn township and near-by towns was held at Centre recently to organize the New Park & Fawn Grove Railroad Company, whose proposed line will be nine miles in length. It will extend from Stewartstown to New Park and Fawn Grove. The capital is placed at $90,000. The new road is to be operated by the Stewartstown Railroad Company. John C. Wiley was chosen temporary president.

SPRINGFIELD, OHIO—President John L. Plummer, of the Commercial Club, D. King Gotwald and others have interested New York capitalists in an electric line to be built from Yellow Springs to Clifton, thence to Cedarville and Jamestown, and eventually to Wilmington. Entrance to Springfield will be made by connecting with the Springfield & Xenia road at Yellow Springs. Work of constructing the new road will be started this spring.

WILLIAMSPORT, MD.—At the annual meeting of the stockholders of the Hagerstown Street Railroad Company the following officers were elected to serve for the ensuing year; president, Christian W. Lynch; vice-president, Donald C. Haldeman; treasurer, William Jennings; secretary and superintendent, W. C. Hepperle; directors, Christian W. Lynch, William Jennings, J. Clarence Lane, W. C. Hepperle, J. I. Bitner, H. H. Keedy, Jr., and Edward W. Mealey.

SCRANTON, PA.—Work has been begun at Factoryville on the trolley road, to be constructed from Scranton to Tunkhannock. The company is partly made up of Scranton capitalists, among whom are J. Seldon Swisher, Lewis B. Carter, James P. Dickson, Frederick E. Scott and C. W. Seeley. The contract for the construction of the road has been awarded to the American Lime, Stone and Cement Company, of Berwick, Pa. The road will be built for high-speed travel.

TOLEDO, OHIO—Negotiations have been closed for the electrical equipment for the new Toledo, Port Clinton & Lakeside permanent power plant, to be located at Port Clinton or Oakharbor. The contract was secured by the Allis-Chalmers Company, the plant complete to be turned over to the railway company on or before July 1. Plans have also been perfected for the purchase of ties and other equipment to complete the road to Marblehead, and cars will be in operation between Toledo and Marblehead by July 1.

MATTOON, WIS.—Surveys for the new electric passenger and freight road, between Clintonville, Mattoon and Antigo, to be known as the Red River Valley Electric Railway, will be completed in April, and it is expected that cars will be running over the line by July 1. The road will begin at Clintonville, run thence to Eland Junction, thence to Mattoon, thence to Phlox, and thence to Antigo. The line is being surveyed for a double track, and it is said it may be extended to the Republic, Mich., iron mines.

JOHNSTOWN, PA.—The Northern Cambria Street Railway Company, which has projected a trolley line from Patton to St. Boniface, Hastings, Barnesboro, Spangler, St. Benedict and Carrolltown, has elected the following directors: Rembrant Peale, S. R. Jackman, Thomas Barnes, George W. Hoover, James H. Allport, F. H. Bigler, W. D. Bigler, W. H. Denlinger, George M. Wertz, F. H. Parker, F. O. Botts and R. A. Shillingford. The directors have elected as officers W. H. Denlinger, president; Rembrant Peale, vice-president, and James H. Allport, secretary.

PERSONAL MENTION.

MR. H. T. PAISTE, of Philadelphia, was among the pioneer electrical manufacturers who spent several days in New York recently.

MR. H. O. PHILLIPS, of Pawtucket, R. I., the well-known manufacturer of insulated and copper wire, was a New York visitor last week.

MR. CHARLES F. MUNDER, president and treasurer of the Munder Electric Company, Springfield, Mass., was a visitor in Chicago during the past week.

MR. CHARLES E. BROWN, of the Central Electric Company, and Mr. W. W. Low, of the Electric Appliance Company, were among the electrical visitors from Chicago in New York city during the past week.

MR. H. R. MASON, manager of the local Bell telephone exchange at Ann Arbor, Mich., has been made superintendent of the Saginaw district. He will be succeeded at Ann Arbor by Mr. Thomas Harbaugh, of Detroit.

MR. ARTHUR WARREN, manager of publicity for the Allis-Chalmers Company, delivered his very interesting address, entitled "A Plain Talk on Trade Journals," before the Chicago Trade Press Association February 28.

MR. A. A. THRESHER, of the Thresher Electric Company, of Dayton, Ohio, has been confined to his room at the Waldorf-Astoria, in this city, for ten days past with a badly sprained ankle. He was able to be out Monday of this week.

MR. FRED F. CLARK, manager of the Clark Electric Specialty Manufacturing Company, Minneapolis, Minn., made a visit to Chicago during the past week. Mr. Clark reports that the electrical specialty business is at its best at the present time.

MR. B. A. SCHRODER, for some time attached to the St. Louis office of the Crocker-Wheeler Company, has been placed in charge of the New Orleans office of the company. Mr. Schroder succeeds Mr. W. P. Field, who has been transferred to the Boston office.

MR. W. S. SISSON, of Providence, secretary of the D. & W. Fuse Company, spent several days at the Hotel Imperial last week. Mr. Sisson's company is moving to its enlarged and modern factory, where facilities for turning out its product have been greatly increased.

MR. F. S. PALMER, formerly electrical engineer for the Consolidated Engine-Stop Company, New York city, has associated himself with the Locke Regulator Company, Salem, Mass. This company is the manufacturer of an automatic engine-stop and speed-limit system.

MR. E. P. SIMMONS has resigned his post with the Interstate Electrical Company, Atlanta, Ga., to become secretary and treasurer of the P. E. Allison Company, of Atlanta. This company has recently been reorganized and reincorporated under the name of the Allison-Simmons Company. Mr. P. E. Allison is the president.

MR. M. W. WOOD, for the past three years an electrical engineer with the General Electric Company, Schenectady, N. Y., will shortly engage in consulting engineering in Chicago, Ill. Mr. Wood was district engineer for the Edison Illuminating Company, at Portland, Ore., prior to the consolidation of the Edison and Thomson-Houston companies.

MR. E. B. GUNN, formerly superintendent of the Richmond, Ind., Street Railway Company, has been appointed manager of the Springfield, South Charleston, Washington Court House & Chillicothe Electric Railway Company. Mr. Gunn was superintendent of the Dayton, Springfield & Urbana Railway Company prior to his appointment with the Richmond company.

MR. ARTHUR C. RALPH, for several years in charge of the Marlboro street railway system as superintendent, and formerly general superintendent of the Boston & Worcester system, has been appointed general manager of the Taunton & Pawtucket and the Middleboro, Wareham & Buzzard's Bay street railway systems.

MR. ARTHUR WILLIAMS has been appointed by President Davis to report on municipal ownership at the twenty-eighth convention of the National Electric Light Association. This convention will be held at Denver and Colorado Springs, Col., June 6 to 11. Mr. Williams has already in hand a large amount of statistics regarding municipal ownership of plants, both in this country and abroad. His report on decorative and sign lighting has attracted a great deal of attention wherever electric light has been used, and there is no doubt that the coming report on municipal plants will be of equal value and interest.

MR. FREDERICK P. FISH, president of the American Telephone and Telegraph Company, addressed the members of the Beacon Society at the Algonquin club-house, Boston, Mass., on the evening of February 28. Mr. Fish was the chief guest and only speaker of the evening. He paid a tribute to the three great inventors of the last one hundred years—Eli Whitney, the inventor of the cotton gin; Robert Fulton, who developed the steamboat, and Alexander Graham Bell, who produced the telephone. Apropos the future of the telephone service, Mr. Fish remarked that the number of subscribers in New England had more than doubled in the last three years over the total of the previous twenty-four years. He was confident that the next three years would see the present number more than doubled.

MR. FRANK B. KNIGHT, of Dallas, Tex., will hereafter be an official of the Southwestern Telephone and Telegraph Company, resigning as special agent of the American Telephone and Telegraph Company. Mr. Knight has been identified with the Bell telephone interests since 1880. The Dallas *Morning News* says: "Mr. Knight was assigned to duty in the Southwest in 1886, having jurisdiction over the states of Arkansas, Texas, Louisiana and Mississippi and Oklahoma and Indian Territories, with headquarters in Austin, Tex., from which place he removed to Dallas in the early part of 1902. Mr. Knight has always entertained an abiding faith in the possibilities of the telephone business throughout this section of the country, and has lent his aid in furthering every project that had for its object increased facilities or the more efficient working of the system, and he has the satisfaction of knowing that in no part of the United States has a higher degree of excellence been attained in telephone operation than is to be found in the territory with which he has so long been connected."

OBITUARY NOTICES.

MR. WILLIAM WALTER FAGIN, chief canvasser of the Colorado Telephone Company, Denver, Col., died on the evening of February 23, in Denver. He had been in the employ of the company for over three years, and was one of its most popular and efficient men.

MR. FRANK SCHIFFHAUER, superintendent in charge of construction work of the Mexican Light and Power Company, Mexico City, Mexico, died on the morning of February 18, as the result of injuries which he received during the fire at the company's power-house.

MR. FRED A. LA ROCHE, proprietor of the F. A. La Roche Company, New York city, died on Saturday, March 4. Mr. La Roche was widely known throughout the electrical fraternity. He was an enthusiastic automobilist. He was buried on Thursday afternoon from Germantown, Philadelphia.

MR. RICHARD SOMERS HAYES died on Thursday, March 2, in New York city. Mr. Hayes was formerly president of the St. Paul & Duluth Railroad and the New York & Northern, and vice-president of the Missouri Pacific Railroad Company. He built the Texas & Pacific, and was receiver of the Texas International. He was a director of the Brooklyn Rapid Transit Company, the Acheson, Delaware & Hudson, Long Island and other railroads.

MR. DUDLEY B. WICK, JR., chief of the engineering department of the North Electric Company, Cleveland, Ohio, died on the morning of March 1. He had been ill for about a week with a severe attack of the grippe, and this brought about a brain complication which caused his death. He was a student of the university and high schools of Cleveland, Ohio, and graduated from Cascadilla in 1898. He took special courses, preparatory to his entering upon the profession of electrical engineer, at both the Case School of Applied Science and Cornell University. He became connected with the North Electric Company a few years ago, and by tireless energy speedily rose from a subordinate position to that of chief of the engineering department. This responsible position he filled with great success, and he had won a high place for himself among his business associates.

ELECTRIC LIGHTING.

ROCKFORD, ILL.—The Rockford Edison Company will make extensive improvements to its system.

HOPKINS STATION, MICH.—W. F. Nicoli will establish an electric light plant at Hopkins Station.

ELGIN, ILL.—Elgin has leased its electric plant to the local traction company, from which it will purchase current.

FORT VALLEY, GA.—Fort Valley has voted for a municipal electric light plant. Bonds to the amount of $12,000 will be issued.

LEAVENWORTH, KAN.—Local capitalists have completed arrangements for the building of a $5,000 electric light plant at Onaga.

STILLWATER, MINN.—Fire recently partially destroyed the Stillwater electric light plant, which cost $18,000. The loss will reach $5,000.

ALBANY, N. Y.—Governor Higgins has signed the bill authorizing Ilion to raise $25,000 for the establishment of an electric lighting plant.

MEXICO, MO.—The Mexico electric light plant has been granted a twenty-year franchise, and a contract for extensive street lighting will be made.

WILMINGTON, DEL.—The Colonial Beach Electric Light and Power Company has received a twenty-year franchise for a plant in Colonial Beach, Va.

FENELON FALLS, ONTARIO—The new electric lighting and power plant, built by the town of Fenelon Falls at a cost of $30,000, is now in running order.

JEFFERSON CITY, TENN.—The Jefferson City Electric Light Company has purchased the Forche tannery property, and will erect an electric light plant.

CHICAGO, ILL.—By a vote of five to one the village board of La Grange decided to sell the village waterworks and lighting plant to a private corporation.

NEWTON, N. J.—The Newton Gas and Electric Company has given a mortgage to the Hobart Trust Company, of Passaic, to cover an issue of $200,000 bonds.

MARION, S. D.—The Marion town council has awarded to J. A. Heeren and other business men a franchise for the installation and operation of a lighting system.

SODUS, N. Y.—The electric lighting franchise granted citizens of Sodus, about one year ago by the town board, has been transferred to other business men of the place.

SALEM, S. D.—Mark Donahue and P. G. Williams, of Montrose, are at work organizing a company at that place for the purpose of installing an electric lighting plant.

MANDAN, S. D.—George Horn has sold out his interest in the Cavalier electric light plant to James Lang, who is now the sole owner. The plant will be enlarged and improved.

SOUTH BEND, WASH.—J. M. Etnier has been granted a forty-five-year franchise for furnishing electric power and lights to South Bend. Local capital is back of the new enterprise.

COLUMBUS, OHIO—The contract for the electric lighting in the state house, for the ensuing year, has been awarded to the Public Service Company. The bid was three cents per kilowatt.

NASHVILLE, TENN.—The mayor and board of aldermen of Huntington have closed a deal with W. J. Holman, by which he takes charge of the city's electric light and water plant on a five-year lease.

SYDNEY, CAPE BRETON—A resolution has been passed by the Sydney city council appointing a committee to secure legislation necessary for the purpose of installing an electric light plant to be owned by the city.

RENO, NEV.—The Southern Pacific Company is constructing an electric light plant at Carlin, Nev., which will be used in lighting switches and station houses at many little stations in that portion of the state.

HANNIBAL, MO.—The new electric plant of the city of Hannibal was put into operation recently. The plant cost $100,000, and is up to date in every respect. The street railway company has arranged to receive its motive power from the plant.

HACKENSACK, N. J.—As a result of a meeting of the directors of the Gas and Electric Company, of Bergen County, and a session of the stockholders of the concern the plan to lease the plant to the Public Service Corporation for 999 years was ratified.

LOUISVILLE, KY.—At the annual meeting of the Evansville Gas and Electric Company, the following officers were elected: president, E. B. Lewis, of Chicago, Ill.; vice-president, F. J. Reitz; secretary, W. B. McDonald; treasurer and auditor, James H. Foster.

WILKESBARRE, PA.—Contracts for new machinery and engines have been let by the Wyoming Valley Gas and Electric Company as a step toward the improvements the company is promising to residents of the West Side. The contracts call for the expenditure of about $50,000.

TORRINGTON, CT.—The annual meeting of the Torrington Electric Light Company was held recently. The directors were reelected as follows: George D. Workman, Henry J. Hendey, Gideon H. Welch, James A. Doughty, Frank Travis, John Workman and Frederick F. Fuessenich.

WHEELING, W. VA.—The newly organized Ohio Valley Electric Light Company, of Benwood, has elected the following officers: general superintendent, William H. Snider; president, Thomas P. Deegan; vice-president, Charles P. Kinney; secretary, William Leach, Jr.; treasurer, Charles Schad.

SYLACAUGA, ALA.—At a recent meeting of the Sylacauga city council the sale of $24,000 of city bonds was confirmed. The bonds were sold to H. L. McEldry, of Talladega, Ala. The proceeds will be used solely for the purpose of erecting an electric light and waterworks plant in Sylacauga.

CARLISLE, KY.—The plant of the Citizens' Electric Light Company was entirely destroyed by fire on February 18, causing a loss of $8,000, with insurance of $2,000. The destruction of the plant will leave the city in darkness until temporary arrangements can be made to supply illumination.

STILLWATER, MINN.—A trust deed for $500,000 has been filed by the Stillwater Gas and Electric Company in favor of the American Loan and Savings Company, of Chicago. The deed is to cover bonds issued by the company, with the proceeds of which extensive improvements are to be made.

DILLON, COL.—W. H. Foster, who last fall purchased the old Ora Grande placer workings, a half mile north of Dillon, has interested New York capital, and will shortly begin the construction of a large electric power plant on the property. The ditch from which the water power will be obtained is nine miles long.

OTTAWA, ILL.—The McKinley syndicate, controlling and operating the interurban electric lines of the Illinois Central Traction Company, the St. Louis & Springfield Electric Railway Company, and the St. Louis & Northeastern Railway Company, has purchased the power plant of the Edwardsville Electric Light and Power Company.

MALONE, N. Y.—The Paul Smith Hotel Company has bought the Saranac Lake Light, Heat and Power Company, the capital of which is $100,000. The power will also be used in running the electric trolley line now in course of construction between Lake Clear Junction and the Paul Smith hotel, located on St. Regis lake.

ONEIDA, N. Y.—The Oneida board of public works has ordered the Madison County Gas and Electric Company to remove its high-tension wires running through Madison street to furnish power for the village of Canastota. Hereafter the board of public works will oversee the erection of wires to carry high-power electric currents in this city.

BOSTON, MASS.—A petition has been received by the gas and electric light commissioners from the Lynn Gas and Electric Light Company, asking for authority to issue additional stock to the

amount of $230,000, the proceeds of which are to be devoted to funding floating indebtedness and for the payment of expenses incurred by the company.

KEWANEE, ILL.—At the annual meeting of the Kewanee Light and Power Company, Xenophon Caverno, James K. Blish and B. C. Parkinson were elected directors for the coming year. The directors chose officers as follows: president and general manager, Xenophon Caverno; vice-president, James K. Blish; secretary, B. C. Parkinson.

OROVILLE, CAL.—E. W. Sutcliffe, for the Northern California Electric and Navigation Company, has been granted a franchise for one year and eleven months for a pole line to transmit electricity over the streets and highways of Butte County. The object of this two-year franchise is to allow the company to immediately construct its line.

HAMILTON, OHIO—The Hamilton Gas and Electric Company has filed a mortgage for $1,000,000 in favor of the Union Savings Bank and Trust Company, of Cincinnati. The mortgage covers the entire assets of the company, and includes, in addition, a bonded debt of $540,000 of the Hamilton Otto Coke Company, which is absorbed in the new corporation.

ST. LOUIS, MO.—The following officers were elected at the annual directors' meeting of the Union Electric Light and Power Company: John I. Beggs, of Milwaukee, president; Julius S. Walsh, first vice-president; Charles W. Wetmore, second vice-president; Breckinridge Jones, treasurer; Harold P. G. Coates, secretary, and W. V. N. Powelson, general manager.

DES MOINES, IOWA—The Valley Junction electric light and water plant, which has been in the hands of eastern capitalists, has been sold to four citizens of the home town, who will incorporate under the laws of Iowa and form a stock company. The title will be transferred to John Fisher, A. H. Dyke, J. T. and Charles Ashworth, of Valley Junction.

ALBANY, GA.—The contract for the erection of the dam and power-house of the Albany Power and Manufacturing Company has been awarded to B. H. Hardaway, of Columbus. The terms of the contract call for the completion of the dam and power-house by the first of September. The work involves an amount in excess of $100,000. Construction will begin at once.

ST. PAUL, MINN.—The redraughted form of the ordinance permitting the Union Manufacturing Company to extend its electric lighting system in the western portion of St. Paul has been approved by the board of aldermen. The measure now provides for a bond of $25,000, and allows other public service corporations to use the poles on the payment of a proportion of their cost.

TROY, N. Y.—A petition for the renewal of the charter of the Hoosac Electric Power Company has been presented to the legislature by W. S. Kelly, of North Adams, Mass. The charter was granted some time ago, but was dissolved shortly after. An immense power plant at Howe's pond has been planned by the company to supply power to Adams, North Adams and surrounding places.

UNIONTOWN, PA.—The agreement of merger and consolidation whereby eleven electric light companies have been consolidated, forming the Western Pennsylvania Electric Company, has been recorded. The capital stock is $337,500. The officers are William S. Kuhn, president; Jacob Van Wagener, vice-president; Jesse H. Purdy, secretary, and John F. Cockburn, treasurer, all of Pittsburg.

EAST HADDAM, CT.—The firm of Ransom & Hoadley, of Providence, has bought the stock and entire rights of the Salmon River Power Company, which is controlled by the Connecticut River Banking Company, of Hartford, and expects to enlarge the plant at Leedsville, and spend about $300,000 in improvements. The Salmon River Power Company has furnished power for the East Haddam Electric Light Company at Leedsville.

PITTSBURG, PA.—Homestead is to have an independent electric light company, with George S. Debolt and W. S. B. Hays as its promoters. Announcement of the formation of a stock company was made recently, and it was stated that work on the erection of the plant would be commenced within a short time. Light and power will be sold in Homestead and surrounding boroughs, and power furnished to the Homestead & Mifflin Street Railway Company.

AGUILAR, COL.—A mass meeting of Aguilar citizens was held recently, at which definite steps were taken toward securing a municipal electric light plant for Aguilar. A stock company will be formed and a $10,000 system installed. At the end of five years the city will have the option of purchasing the plant. A site has been secured, and the erection of the plant will be begun soon. Among the leading stockholders are A. R. Lindsey, Morris Pitti, H. Pinamonti and B. Harbison.

ALPENA, MICH.—The incorporation of the Alpena Power Company has been completed. The capital stock is $99,000 and the officers are F. W. Gilchrist, Alpena, chairman; Russell A. Alger, Detroit, vice-chairman; George P. Smith, recently of Ann Arbor, secretary; Frank W. Fletcher, Alpena, treasurer. The company has absorbed the local water and electric light companies, and secured control and right of way along the Thunder Bay river, preparatory to the erection of a large power plant.

CHESTERTOWN, MD.—The board of town commissioners of Chestertown, Md., has granted a franchise for the erection of poles, wires, etc., for the installation of a modern and thoroughly equipped electric light plant. The franchise covers a period of forty years, and a lot has been leased for ninety-nine years for the erection of a plant. The machinery is to be in place and the wires ready for operation by April 1. Two dynamos will be installed, capable of generating a current that will furnish light, not only to Chestertown, but to near-by towns, such as Church Hill, Centreville, Millington, Still Pond, Rock Hall, Kennedyville, Galena and Betterton.

BANGOR, ME.—The Maine & New Brunswick Electric Power Company will, in the early spring, begin the development of its property at Aroostook Falls, and before the end of the year is to have in operation a plant to supply electric light and power to a number of towns in Maine and New Brunswick. Arthur R. Gould, of Presque Isle, is a leader in the enterprise. About one hundred acres of land have been purchased adjacent to the falls, and preparations are now being made for the erection of the buildings. The falls afford, in a fall of seventy-five feet, about 4,000 horse-power. At the beginning the company will install five pairs of water-wheels of 400 horse-power each, sufficient for the lighting of the principal towns of Aroostook County and the towns of Perth and Andover in New Brunswick.

DIXON, ILL.—The Lee County Lighting Company—John I. Beggs, of Milwaukee, president; H. C. Higgins, of Dixon, vice-president and general manager, and J. H. Vandyke, Jr., of Milwaukee, treasurer—has closed a deal for the purchase of the interests of the Dixon Power and Lighting Company, including the local electric light and gas plants and the company's three-fourths interest in the Rock river dam, completed last September. Two hundred thousand dollars is involved in the transaction. The purchasers own an extensive gas plant here and the Sterling, Dixon & Eastern electric railway, which has been in operation the last six months. The capital stock of the Dixon company is $100,000, with $50,000 in bonds, and another $50,000 in floating indebtedness. The Lee County corporation has an authorized capital of $1,000,000, and a bond issue of $1,000,000.

SCRANTON, PA.—The stockholders of the Suburban Electric Light Company have elected officers and directors as follows: president, A. L. Snowden; vice-president, G. M. Hallstead; secretary and treasurer, E. M. Stack; F. E. Platt, W. F. Hallstead, M. W. Collins, F. B. Bull, B. Moses and A. L. Francois. The old board was reelected. The Dunmore Light, Heat and Power Company has organized by electing the following officers and directors: president, A. L. Snowden; secretary and treasurer, E. M. Stack; G. M. Hallstead, F. B. Bull, H. H. Knapp, M. J. Murray, R. D. Manley, John Carney and M. B. Freedman. The Scranton Illuminating, Light, Heat and Power Company has organized by the election of the following officers and directors: president, A. L. Snowden; vice-president, G. M. Hallstead; secretary and treasurer, E. M. Stack; W. F. Hallstead, M. W. Collins, Theodore G. Wolfe, Franklin Howell.

NEW INCORPORATIONS.

CONCORD, N. H.—Citizens' Telephone Company. $100,000.

WIGGINS, ALA.—Wiggins Electric Light Company. $10,000.

DES MOINES, IOWA—Maquoketa Light and Heat Company. $12,500.

AMELIA, NEB.—South Fork Independent Telephone Company. $2,000.

FRANKLIN, N. H.—The Canterbury & Boscawen Telephone Company. $1,500.

WABASH, IND.—Home Telephone Company. Increased from $20,000 to $50,000.

SPOKANE, WASH.—Spokane Southern Traction Company. Increased to $2,000,000.

EATON RAPIDS, MICH.—Eaton Rapids & West Aurelius Telephone Company. $3,000.

SOLSVILLE, N. Y.—Madison Mutual Telephone Company. Increased from $1,000 to $5,000.

NEWARK, N. J.—Milwaukee Light and Power Company. Increased from $500,000 to $1,000,000.

COLUMBUS, OHIO—Washington Gas and Electric Company. Increased from $100,000 to $150,000.

AUGUSTA, ME.—Home Light and Heat Company. $300,000. President, M. H. Simmons; treasurer, E. F. Whittum.

SCRANTON, IOWA—Scranton Independent Mutual Telephone Company. $5,000. Incorporators: R. S. Lowe, and others.

LA CROSSE, WASH.—Farmers' Rural Telephone Company. $1,000. Incorporators: W. J. Sharp, W. C. Fudge, A. E. Benner.

DES MOINES, IOWA—Harmony & Kendallville Farmers' Telephone Company. $600. Incorporators: Emmet Benson and others.

PAWNEE, ILL.—Sangamon County Telephone Company. $20,000. Incorporators: H. E. Farnam, E. L. Farnam and H. M. Farnam

LEXINGTON, ILL.—Prairie Hall Telephone Company. $4,000. Incorporators: Gilson H. Elder, John A. Moon and George C. Elder.

LINCOLN, NEB.—Ogalalla & Big Springs Telephone Company. $55,000. Incorporators: James Gray, E. D. Harrison and W. J. Harris.

EAST ST. LOUIS, ILL.—St. Clair Light and Power Company. $75,000. Incorporators: C. L. Gray, H. C. Barnard and R. W. Sikking.

CHICAGO, ILL.—Blue Island, Riverside & Hammond Railway Company. Changed to Chicago & Interurban Electric Railway Company.

BAKER CITY, ORE.—Farmers' Mutual Telephone Company. $2,000. Incorporators: George Ebell, Lee Stewart and E. M. Chandler.

MADISON, N. J.—The Western Water and Electric Company. $100,000. Incorporators: Charles E. W. Smith, George M. Ward, John H. Gindrat.

WALLA WALLA, WASH.—Walla Walla Railway Company. $500,000. Incorporators: E. S. Isaacs, F. E. Smith, Grant Copeland, William O'Donnell.

GUTHRIE, OKLA.—German-American Telephone Company. $5,000. Incorporators: H. C. Arnold, E. E. Cowman and D. L. Kinnewan, all of Orlando.

BICKNELL, IND.—Bicknell Light and Power Company. $10,000. Directors: A. L. Brocksmith, B. P. Barnes, J. G. Welton, J. H. Welton and E. G. Barnes.

TYLER, TEX.—White Telephone and Telegraph Company. $10 000. Incorporators: Charles N. White, N. W. White and W. Frank Know, all of Tyler.

GREENVILLE, ME.—Greenville & Kennebec Telegraph and Telephone Company. $10,000. President, C. D. Shaw; treasurer, H. M. Shaw, both of Greenville.

ALBANY, N. Y.—Frankfort, East & West Schuyler Mutual Telephone Company. $1,000. Incorporators: A. Eaton, Elmer J. Ladd and W. Klock, all of Frankfort, N. Y.

HELENA, MONT.—Fort Benton Electric Light Company. $15,000. Incorporators: W. K. Harber, John Harris, Charles Lepley, Jr., James Townsend and L. D. Sharp.

ALBANY, N. Y.—The East Pembroke Telephone Company. $3,000. Incorporators: E. Chapin Richardson, C. K. Durham and C. C. Day, all of East Pembroke, N. Y.

PORTLAND, ORE.—Estacada Telephone and Telegraph Company. $10,000. Incorporators: M. C. Adkins, B. O. Boswell, John B. Haviland, J. W. Reed and R. A. Stratton.

AUGUSTA, ME.—Lorimer Automatic Telephone Company. To operate telephone lines. $10,000,000. President, G. R. Hadlock, Augusta; treasurer, E. F. Whittum, Augusta.

EAST ST. LOUIS, ILL.—East St. Louis Consumers' Electric Light, Power and Heat Company. $75,000. Incorporators: H. J. Dehaan, Fred W. Zegenheim and Charles O. Clark.

PORTLAND, ORE.—American Telegraph and Telephone Company. To construct telegraph and telephone lines, etc. $10,000. President and treasurer, C. H. Adams, Boston, Mass.

ALBUQUERQUE, N. M.—Las Cruces Electric Light and Ice Company. $5,000. Incorporators: B. L. Berkley, Theodore Honault, Henry D. Bowman and Herbert B. Holt, of Las Cruces.

GULFPORT, LA.—West Gulfport & Race Track Street Railway Company. $25,000. Incorporators: Phil. A. Dolan, J. R. Hill, J. R. Pratt, S. P. Moorman, E. S. Burrill, W. R. Bachellor, J. T. Richardson and P. H. M. Tippin.

GUTHRIE, OKLA.—Byron Rural 'Phone Company. To construct a telephone line between Mendon and Byron. $1,000. Incorporators: H. B. Holderby, M. Sluder and W. M. McRay, all of Byron, Okla.

BAIRD, TEX.—Home Telephone and Electric Company. $25,000. Incorporators: I. N. Jackson, S. L. Driskell, T. E. Powell, S. H. Ramsey, Bennie Richardson, all of Baird, and J. M. Estes, of Clyde, Tex.

PIERRE, S. D.—Watertown Transportation Company. Formed for the purpose of constructing a ten-mile line to lake Kampeska. $100,000. Incorporators: Charles Hamilton, of Chicago; Percy Cocks, of Brooklyn; O. C. Berg, of Redfield, and Alfred L. Rowe and William D. Rowe, of Watertown.

DENVER, COL.—Elk Mountain Mutual Telephone Company. To supply telephone service to Roult, Western Lorimer, Rio Blanco, Eagle and Grand counties. $37,500. Directors: James B. Male, Fred S. Follett, William W. Adair, William M. Hitchens, William H. Dingfield, Charles Blackburn and Patrick Cullen.

NIAGARA FALLS, N. Y.—Niagara Falls Electrical Transmission Company. To manufacture and supply gas and electricity for lighting, domestic and manufacturing purposes in cities, villages and towns of Niagara, Erie, Orleans, Genessee and Monroe counties. $100,000. Directors: Harry Highland, Frank A. Fudley, Niagara Falls; Frederick Nicholls, W. R. Wood and D. E. Thomson, Toronto, Ontario.

ALBANY, N. Y.—Hornellsville, Bath & Lake Keuka Railroad Company. To construct an electric railroad from Kinona to Bath, Steuben County, a distance of five miles. $50,000. Directors: Linn D. Nasson, J. Seymour Hubba, J. F. Turk, Hammondsport; Thomas Shannon, Bath; Leslie D. Whiting, Canisteo; W. H. P. Gilmore, Turner's Falls, Mass.; Sayward Hilbraith, Springfield, Mass.; Frederick Gailbraith, Cincinnati; Walter H. Miller, East Orange, N. J.

ALBANY, N. Y.—New York Independent Telephone Company. To operate a telephone system in New York city, and thence to Albany and Boston, connecting intermediate cities in New York, Massachusetts, Rhode Island and Connecticut, and also through New Jersey and Pennsylvania to Jersey City, Philadelphia and other places. $50,000. Directors: S. Lee, Jr., James M. Woods, B. S. Mantz and Horace S. Gould, of New York city; H. O. Coughlan, of Brooklyn; J. R. Turner, of Basking Ridge, N. J., and Kenneth K. McLaren, of Jersey City.

ELECTRICAL SECURITIES.

For the first time since the beginning of the year a really buoyant feeling seems to pervade all business enterprises. The market continues to show high security values and the most conservative opinions point to a condition of stability not often concurrent with a high-priced market. Holdings seem to be in strong hands, and the present way of looking at industrials is not so much on the side of their immediate dividend-paying values as on the side of their investment value some time hence. In all directions there is a noticeable demand for manufactured products, and in the iron and steel trade practically all the companies are enjoying a very fair amount of business. Not only in these large interests is there an awakened activity, but in smaller lines, and particularly in construction specialties is there a brisk and improving trade. Railroad earnings are not as favorable as usual, but this is probably due to restrictions from bad weather. That large expansions are contemplated is evident from the new work going on on every system, and the recent large orders for additional equipment.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 4.

New York:	*Closing.*
Brooklyn Rapid Transit	66½
Consolidated Gas	212
General Electric	188
Interborough Rapid Transit	206
Kings County Electric	200
Manhattan Elevated	170⅜
Metropolitan Street Railway	123⅜
New York & New Jersey Telephone	172
Western Telephone and Telegraph preferred	192

The following were elected directors of the Kings County Electric Light and Power Company for the ensuing year, at a meeting held February 27: A. N. Brady, N. F. Brady, William Berri, Horace C. Duval, Walton Ferguson, W. W. Freeman, Bernard Gallagher, Hugh J. Grant, Seth L. Kenney, Edward A. Leslie, Thomas E. Murray, W. F. Sheehan and A. M. Young.

The quarterly statement of the New York City Railway Company for the quarter ended December 31, 1904, is as follows: gross, $4,286,275; expenses, $2,354,407; net, $1,931,868; other income, $318,731, a total of $2,250,599; charges, $2,791,543, leaving a deficit of $540,944.

Boston:	*Closing.*
American Telephone and Telegraph	146
Edison Electric Illuminating	250
Massachusetts Electric	62
New England Telephone	137
Western Telephone and Telegraph preferred	102

Boston Elevated stockholders have approved an issue of $11,000,000 bonds for construction and funding floating debt.

The American Telephone and Telegraph Company received bids for $25,000,000 4 per cent collateral trust bonds, due in 1929. The bonds were awarded to Kidder, Peabody & Company and Baring Brothers.

Both gross and net earnings of the Massachusetts Electric Companies are making very good gains over last year. For the first two months of 1905 gross earnings have increased over $1,000 per day, amounting to about $70,000, which is $25,000 in excess of the increase in gross earnings on the entire system for the year ended September 30, 1904. New stock to the amount of $2,461,512 is to be used by the Old Colony Street Railway Company and the Boston & Northern Street Railway Company (controlled by the Massachusetts Electric Companies) for the purpose of improving the systems.

Philadelphia:	*Closing.*
Electric Company of America	12⅛
Electric Storage Battery common	87
Electric Storage Battery preferred	87
Philadelphia Electric	10¾
Philadelphia Rapid Transit	29⅝
United Gas Improvement	116¼

The directors of the Philadelphia Traction Company (controlled by the Philadelphia Rapid Transit Company) have declared a dividend of $2 per share, payable April 1.

Chicago:	*Closing.*
Chicago Telephone	143
Chicago Edison Light	170
Metropolitan Elevated preferred	61
National Carbon common	43
National Carbon preferred	114
Union Traction common	12
Union Traction preferred	50

Chicago Telephone directors have declared the regular quarterly dividend of 2½ per cent, payable March 31. Books close March 27 and reopen April 1.

The National Carbon Company has issued its report for the year ended January 31, 1905, as follows: net earnings, $846,307; preferred dividends, $315,000, leaving a balance of $531,307; charged off, depreciation, etc., $383,336, and common dividend, $82,500, leaving a surplus of $65,471, as compared with $141,012 for the preceding year.

For the fiscal year ended February 28 Metropolitan Elevated carried 115,700 passengers daily, against 113,000 for the previous year.

INDUSTRIAL ITEMS.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Milwaukee, Wis., announces that it has received an order from the Northern Electrical Manufacturing Company, of Madison, Wis., for 135 of the new type of C. H. machine tool controllers, equipped with fuses and switch in conformity to the United States Navy specifications. All of these controllers will be installed in the plant of the Winchester Repeating Arms Company. Although this controller has been on the market but a few months, its sales have far exceeded the most sanguine expectations of the Cutler-Hammer Manufacturing Company.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is exhibiting its mercury arc rectifier at the Motor-Boat and Sportmen's Show, in Madison Square Garden, New York city. In the exhibit of the Electric Launch Company is shown one of the mercury arc rectifiers in full operation. It is used to charge forty-four cells of battery in the electric launch "Rest-Awhile," the current being thirty amperes at 110 volts, direct current; the alternating current used is 220 volts, sixty cycles. This presents an interesting field for the use of mercury arc rectifiers, and it is probable that the use of electric launches may be materially increased because of the simplicity of the charging outfit now offered.

THE HYDREX FELT AND ENGINEERING COMPANY has just commenced business at 120 Liberty street, New York city, and devotes its energies exclusively to the subject of waterproofing. This is a branch of engineering which has hitherto been comparatively neglected, but with the great activity in tunnel building and in structural work requiring deep foundations, the importance of the subject now warrants the attention of specialists. This company states that it is the first company which, besides offering waterproofing material, also draws up plans and specifications and attends to the engineering details of this class of work. The manager of the new company is Edward W. DeKnight, who has taken a prominent part in preparing the plans for waterproofing a number of great engineering enterprises. The new company is an off-shoot of the old-established concern of F. W. Bird & Son, East Walpole, Mass., and starts business under favorable auspices, as "Hydrex" felt has been specified for the Pennsylvania tunnel under New York city, the B. & O.-Pennsylvania improvements at Washington and other important projects.

H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York, announces that "Kearsarge" gasket tubing is a recent addition to the well-known list of "Kearsarge" packings, manufactured by it. Gasket tubing is especially desirable for certain conditions, is easy of application, efficient and an article in which all engineers should be interested. The same company is also furnishing Kearsarge ring packing, a new form of its well-known coil packing. These rings can be furnished in any size and quantity, and the high standard of efficiency of its entire line of packings is maintained in this new product. Samples and printed matter may be

obtained from the company's offices in New York, Milwaukee, Chicago, St. Louis, Boston, Philadelphia, Pittsburg, Cleveland and New Orleans.

THE POPE MANUFACTURING COMPANY, Hartford, Ct., has issued its annual catalogue descriptive of Columbia and Hartford bicycles.

THE NEWTON MACHINE TOOL WORKS, INCORPORATED, Philadelphia, Pa., has issued a catalogue describing the Newton vertical milling machine.

THE TURNERS FALLS MACHINE COMPANY, Turners Falls, Mass., has published a large catalogue descriptive of the Crocker triple-diameter-pattern turbine.

THE REMINGTON TYPEWRITER COMPANY, 327 Broadway, New York city, is issuing a pamphlet describing the use of the Remington typewriter for card indexing.

THE WASHBURN SHOPS OF THE WORCESTER POLYTECHNIC INSTITUTE, Worcester, Mass., has issued catalogue C, describing the drill grinders which it manufactures.

THE WESCO SUPPLY COMPANY, Seventh street and Clark avenue, St. Louis, Mo., will be pleased to send its bulletins No. 61 and No. 63, describing the product of its telephone factory.

A. L. IDE & SONS, Springfield, Ill., are distributing a partial list of purchasers of "Ideal" engines. This list is classified and gives a good idea of the extent and variety of service into which these engines enter.

THE NERNST LAMP COMPANY, Pittsburg, Pa., is mailing an attractive folder descriptive of the Nernst street lighting system at Sewickley, Pa. This is reprinted from the ELECTRICAL REVIEW of January 21.

C. H. THORDARSON, Chicago, Ill., has printed a new catalogue descriptive of electrical experimental apparatus, including high-potential transformers, impedance coils, spark coils, permeameters, special apparatus and instruments.

THE GOLD CAR HEATING AND LIGHTING COMPANY, 17 Battery place, New York city, has issued a catalogue describing improved electric heaters and other apparatus for warming elevated, underground, suburban or street railway cars.

THE CONTROLLER COMPANY OF AMERICA, Chicago and St. Louis, is issuing a calendar bearing a picture about ten inches high entitled "The Spirit of the Telephone." On the back are given a number of advantages of telephone service.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, Ill., is distributing a new catalogue describing and illustrating telephone protective apparatus. American self-soldering protectors are listed and described in a separate catalogue. Either of these will be sent upon request.

THE HOWARD MINIATURE LAMP COMPANY, New York, has recently moved into new and enlarged quarters and hereafter will be located at 58-60 Reade street. Mr. H. W. Harper, formerly of the lamp department of the General Electric Company, is president and H. E. Plass secretary.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis., is placing on the market a compact, self-contained type of electric forge blower for metal-working shops. Leaflet No. 145 shows the general types and sizes supplied, and will be sent by the company upon request.

THE GOHEEN MANUFACTURING COMPANY, Canton, Ohio, is issuing two catalogues calling attention to various brands of paint manufactured by the company. One of the catalogues tells of "Galvanum," which the company claims is the only paint that will adhere firmly to galvanized iron.

RUSSELL HOWLAND, 120 Liberty street, New York city, has secured the New York sales agency for the Motsinger Device Manufacturing Company, of Pendleton, Ind. A very interesting booklet is being distributed by the company, describing its autosparker. This booklet will be mailed upon request.

PASS & SEYMOUR, INCORPORATED, Solvay, N. Y., are distributing some attractive advertising literature, calling attention to their national code fuseless attachment plugs, and the P. & S. china wiring tubes. Pass & Seymour pack these tubes in boxes containing 100. In this way the danger of breakage is eliminated.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is distributing an attractive and instructive folder entitled "Wattmeters and How to Read Them." Typical illustrations are shown, and there is added a meter sheet showing a method of marking up meter readings for ready comprehension.

JONATHAN A. RAWSON, JR., 130 Pearl street, New York city, is making a specialty of time-saving devices for offices. A booklet, recently issued, entitled "Doing Things Easily and Quickly in the Office," explains the advantages of a number of pieces of apparatus for office work. Mr. Rawson will correspond with any one interested in the subject.

THE MESTA MACHINE COMPANY, Pittsburg, Pa., has issued catalogue B. This is a handsome book, nine by twelve inches, bound in cloth, and describes the company's shops and the work done by it. The book contains 127 pages, and is well printed and splendidly illustrated by half-tone engravings. In the back of the book are a few pages of very useful tables.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., will be pleased to send its bulletin No. 22, descriptive of the operation and maintenance of the automatic Union electric semaphore signal. A new edition of section eleven—electric locks, electric slots, hand releases and time locks—of the catalogue of interlocking and signaling devices has also been issued.

GEORGE H. BUCKMINSTER & COMPANY, 155 Milk street, Boston, Mass., will be pleased to mail, upon application, a list of the specialties which they carry. Among these specialties are "Munder" lamps, "Hill" specialties, "I. X. L." wire products, Dale portables and specialties, Chase-Shawmut new code fuses and cut-outs, Crescent specialties, Lundin high-tension specialties, and Roche U. S. N. standard dry batteries.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y. is distributing a number of bulletins descriptive of new apparatus. Bulletin No. 4398 illustrates and describes remote-control field rheostats for railway generators and rotary converters; No. 4399, direct-connected generating sets; No. 4400, type H subway transformers; No. 4401, type UP motor-starting rheostats with switches and fuses; No. 4402, complete charging equipments for electric vehicles.

THE KUSEL & KUSEL COMPANY, Chicago, Ill., has closed contracts for automatic systems with the Chicago & Northwestern Railway Company at Chicago, Ill., at New Holstein, Wis., Kiel, Wis., and for the Eastern Wisconsin Telephone Company. The company states that a number of telephone companies are interested in this apparatus, and it is expected that some large contracts will be closed before spring. A new catalogue is now being distributed, describing this automatic apparatus. The company will be pleased to send descriptive data to any one interested.

THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, Cleveland, Ohio, has placed on the market a new type of magnet for handling pig iron, small billets, scrap iron or steel, small steel or iron castings, bolts, rivets, etc., in bulk. This magnet is the result of long experience and persistent experimenting to get the most efficient design. It is adapted to be carried on the hook of a crane, and controlled by the crane man who can thus perform the entire operation of loading or unloading a car, or loading melting stock into charging boxes with no ground helpers. The design of this magnet is radically new, and is covered by letters-patent.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is distributing a pamphlet entitled "Answers to Some Central Station Questions About Single-Phase Motors." The pamphlet is in two parts, the first part being a paper bearing the above title, presented at the October (1904) meeting of the Kansas Gas, Water and Electric Light Association by Mr. G. Percy Cole. The paper takes up the question of installation of polyphase generators and motor service, and discusses the proper number of cycles to use in alternating-current work, and a number of other very interesting questions. Part two is devoted to illustrations of the Wagner Electric Manufacturing Company's machinery.